duration substantially from that estimated in the Proposed Plan and did not change the relative durations among alternatives, so did not change EPA's comparative analysis results from the Proposed Plan. The revised durations are presented in the alternative descriptions in Section 9.2. During the remedy design, a fish migration study will be conducted to better define the fish window.

9.1.3. Engineered Capping

Engineered capping is a key element of two of the active alternatives. The term "engineered capping" refers to placing materials of known characteristics in specifically designed thicknesses over contaminated sediments to sequester them in place (i.e., isolate them from the environment). The engineered cap is planned to consist of sand with varying grain sizes and amounts of organic carbon, designed to provide chemical isolation and to protect against disturbance from bioturbation (mixing of clean cap materials with contaminated sediment by burrowing organisms), erosion, and consolidation and settling of underlying sediments.

During remedial design, other capping technologies (i.e., materials used for capping and how they are applied) that are shown to be equivalently protective may be evaluated. Based on observed sediment bed erosion trends and modeling results, certain areas of the river may need to be armored to reduce the erosion of the sand material, particularly after high flow events. The exact areas and armoring methods will be determined during remedy design. The engineered cap must be monitored and maintained in perpetuity. For cost-estimation purposes, the FFS assumed a 2-foot thick engineered sand cap with six inches of armor stone in some areas. Dredged mudflats would be reconstructed with a layer of sand (or equivalent material) under approximately one foot of habitat substrate.

During remedial design, EPA will evaluate enhanced capping technologies, such as the use of additives (e.g., activated carbon or organoclay) to create a reactive cap or thin-layer capping technologies where conditions are conducive to such approaches. USACE habitat restoration plans for the New York-New Jersey Harbor Estuary could provide additional information on appropriate habitat reconstruction techniques. EPA anticipates that re-deposition of fine-grained material over capped and armored areas will occur over time, making these areas similar in grain size to non-capped areas. Based on studies at other dredged sites, it is expected that, over time, the re-colonized benthic community will likely be similar to the benthic community currently found in the Lower Passaic River, or exhibit greater diversity and abundance than current conditions due to reduced surface sediment contamination.

9.1.4. Removal Actions

All alternatives assume that the Tierra Removal (Phases 1 and 2) and RM 10.9 Removal will have been completed, since they are governed by existing agreements. The agreement for Phase 2 of the Tierra Removal, which EPA entered into with OCC and Tierra in 2008, contemplated

the siting and use of a confined disposal facility[19] (CDF) as a receptacle for the dredged materials. However, this has not occurred and may no longer be practicable, in which case alternate disposal options would be considered. If the approach for addressing the Phase 2 sediments has not been determined by the time the lower 8.3-mile remedial design is underway, EPA expects that this work will be integrated with the lower 8.3-mile remedy in a coordinated and consistent manner.

9.1.5. Five-Year Reviews

Five-year reviews will be required for any of the active remedial alternatives that result in some hazardous substances, pollutants or contaminants remaining in sediments above levels that would allow for unlimited use and unrestricted exposure. This is the case for all except Alternative 2 with DMM Scenarios B and C. In addition, EPA conducts five-year reviews at sites where the time required to achieve the RAOs exceeds five years, as is expected for all the active alternatives.

9.1.6. Dredged Material Management (DMM) Scenarios

9.1.6.1. DMM Scenario A: Confined Aquatic Disposal (CAD)

CAD cells have been shown to be a viable disposal option at other Superfund sediment sites. They can be a technically feasible and cost effective means to dispose of contaminated sediments. The bottom of Newark Bay consists of approximately 60 feet of clay beneath a few feet of silts. In the context of the lower 8.3-mile action, CAD cells would be containment pits excavated into the clay bottom that could serve as disposal sites for contaminated sediments dredged out of the lower 8.3 miles of the Lower Passaic River. In this DMM Scenario, one to three CAD cells approximately 50 feet deep would be excavated into the Newark Bay bottom (see FFS Report Figure 4-1). For cost-estimation purposes, it was assumed that the clay excavated to create the CAD cells would be disposed of in an ocean disposal area, such as the Historic Area Remediation Site in the New York Bight east of Sandy Hook. Final disposal locations would be determined during remedy design. The CAD site would be surrounded by a temporary sheet pile and silt curtain containment system to minimize impacts to Newark Bay during construction and dredged material placement.

The dredged materials would be barged directly to the CAD site in a split hull or bottom dump barge and disposed of in the CAD cells under water. Resource Conservation and Recovery Act (RCRA) regulations exclude dredged material that is subject to the requirements of Clean Water Act Section 404 from the definition of hazardous waste. Dredged material under DMM Scenario A would meet this exclusion, so there would be no requirement that lower 8.3-mile sediments be characterized and/or treated prior to disposal in CAD cells. After each CAD cell is filled, an

[19] A confined disposal facility (CDF) is an engineered structure, built on land or in the water (on the sediment bed) to hold contaminated dredged material, isolating it from the surrounding environment. An in-water CDF may be constructed with sheet pile walls or other containment structures, either against the shore or as an island. Once an in-water CDF is filled, it would be capped, converting open water to dry land.

engineered cap would be placed over the dredged material as final cover, restoring the Bay bottom.

9.1.6.2. DMM Scenario B: Off-Site Disposal

Off-Site Disposal includes two possible components: incineration and landfilling. In the off-site disposal scenario, some lower 8.3-mile sediments have the potential to be characterized as hazardous under RCRA regulations. Based on waste characterization sampling of sediment removed from the river during Phase I of the Tierra Removal, EPA identified that some sediments may be considered hazardous, resulting in a requirement to treat those sediments prior to land disposal; however, RCRA regulations require treatment not just for chemicals that caused the sediments to be classified as hazardous, but for all "underlying hazardous constituents" (i.e., any other chemicals exceeding RCRA's land disposal standards). At this time, incineration is the only technology known to be able to treat sediments if those sediments are characterized as hazardous under RCRA and contain dioxin as an underlying hazardous constituent at concentrations requiring treatment. The ash generated by incineration under this scenario would be disposed of in a RCRA Subtitle C (hazardous waste) landfill. Dredged materials characterized as non-hazardous may be disposed of directly in a landfill without treatment. Since the private parties that performed the Phase 1 Tierra Removal and the RM 10.9 Removal disposed of dredged material in RCRA Subtitle C facilities, EPA expects that the dredged material generated by this action will also go to Subtitle C facilities; and for cost-estimation purposes, placement in a RCRA Subtitle C landfill outside of New Jersey (because there are no RCRA Subtitle C landfills operating in New Jersey) was assumed. Further, the State of New Jersey has no permitted Subtitle D landfills that are authorized to accept dredged materials from coastal or tidal waters for disposal as solid waste, as such materials are specifically excluded from the definition of solid waste under New Jersey regulations.

The dredged materials would be barged or pumped to an upland sediment processing facility in the vicinity of the Lower Passaic River or Newark Bay shorelines. Debris and sand would be separated for disposal or potential beneficial use. The remaining fine-grained material would be actively dewatered using filter presses or another technology to be determined during remedy design. The contaminated water generated from dewatering would be treated at a wastewater treatment plant at the processing facility to meet NJDEP water quality standards and discharged to the Lower Passaic River or Newark Bay. For cost-estimation purposes, EPA assumed that the dewatered dredged material would be transported by rail for disposal, with less than 10 percent requiring incineration and the other approximately 90 percent going directly to permitted landfills. Facilities qualified to accept the materials for treatment and/or disposal have been identified in the United States and Canada.

9.1.6.3. DMM Scenario C: Local Decontamination and Beneficial Use

Local Decontamination and Beneficial Use includes three components: thermal treatment, sediment washing and solidification/stabilization. In this scenario, some lower 8.3-mile sediments have the potential to be characterized as hazardous under RCRA standards. According

to pilot tests of the decontamination technologies, only thermal treatment technologies were able to treat sediments to the applicable RCRA standards if those sediments are characterized as hazardous and contain dioxin as an underlying hazardous constituent. Fine-grained dredged materials characterized as non-hazardous could be treated with a sediment washing technology. Approximately one to two percent of lower 8.3-mile sediments may meet New Jersey standards for beneficial use with little or no treatment. In the FFS, it was assumed that this small percentage would be solidified and stabilized with a binding material such as Portland cement, and then be beneficially used in an industrial setting.

The dredged materials would be barged or pumped to an upland sediment processing facility in the vicinity of the Lower Passaic River or Newark Bay shorelines. Debris and sand would be separated for disposal or potential beneficial use. The portion of the fine-grained material to be decontaminated using thermal treatment and solidification/stabilization would be actively dewatered using filter presses or other technology to be determined during remedy design. The portion of the fine-grained material to be decontaminated using sediment washing would be dewatered after treatment. Water used in sediment washing and generated from dewatering would be treated at a water treatment plant at the processing facility to meet NJDEP water quality standards and discharged to the Lower Passaic River or Newark Bay. For cost-estimation purposes, EPA assumed that less than 10 percent of the dredged materials would require thermal treatment and would generate beneficial use end-products, approximately 90 percent would undergo sediment washing (and potential solidification/stabilization if necessary) for use as RCRA Subtitle D landfill cover in or out of New Jersey, and the remaining few percent would be used for industrial beneficial use with only stabilization.

9.2. Remedial Alternatives

9.2.1. Alternative 1: No Action

Present Value:	$0
Construction Time:	0 years

The Superfund program requires that the No Action alternative be considered as a baseline for comparison with the other alternatives. The No Action alternative would not include any remedial measures, although the Tierra and RM 10.9 Removals are assumed to have been implemented. New Jersey's prohibitions on fish and crab consumption would remain in place.

9.2.2. Alternative 2: Deep Dredging with Backfill

Present Value:	
With DMM Scenario A	$1.21 Billion
With DMM Scenario B	$2.84 Billion
With DMM Scenario C	$2.57 Billion
Construction Time:	14 years

Deep Dredging with Backfill is a bank-to-bank remedy that would involve dredging all contaminated fine-grained sediments throughout the lower 8.3 miles of the Lower Passaic River (9.7 million cy) and placing a layer of backfill[20] over the dredged area to mitigate the effect of residuals[21] remaining after dredging. Backfill would not be maintained after placement, since the intent is that dredging would remove the inventory of contaminated sediments that could become mobile. This alternative is intended to remove the contaminated sediment inventory causing the current and potential future risks in the lower 8.3 miles. This alternative would result in the dredging of the federally authorized navigation channel over its full length within the lower 8.3 miles, since the contaminated sediment inventory is coincident with historic in-filling of the authorized navigation channel.

Within the horizontal limits of the authorized navigation channel, the depth of contaminated fine-grained sediment corresponds well with the depth of historical dredging. Therefore, the depth of dredging under Alternative 2 is assumed to be the historically constructed channel depth plus an additional three feet to account for historical dredging accuracy and over-dredging.[22] The resulting sediment removal depths (all in mean low water [MLW]) are shown in Table 27 in Appendix II.

Outside the horizontal limits of the navigation channel (in the shoals), the depth of contaminated fine-grained sediment to be dredged varies from 3 feet to 20 feet below the sediment surface. Final dredging depths would be refined in the remedy design. Mudflats dredged during implementation of Alternative 2 would be reconstructed to their original grade and would include one foot of mudflat reconstruction (habitat) substrate. USACE habitat restoration plans for the New York-New Jersey Harbor Estuary could provide additional information on appropriate habitat reconstruction techniques.

Dredged materials removed would be managed in accordance with one of three DMM scenarios described in Section 9.1.6.

The construction time estimate (14 years) includes time for dredging, backfilling and dredged material disposal. The construction duration is driven by the time required for dredging and is not influenced by the choice of DMM scenario, because EPA assumes that DMM facilities would be designed and constructed to manage the dredged material throughput without adding to the time needed.[23]

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[20] For cost-estimation purposes, the FFS assumed an average 2-foot backfill layer.
[21] Dredging residuals are the small amounts of contaminated sediments that are inevitably left behind after dredging.
[22] Given the inherent inaccuracies of dredging equipment used for navigational dredging, dredge operators are allowed to "over-dredge," or dredge to depths beyond the project design depth, to make sure that the design depth is achieved. Dredges are more accurate today than historically, so over-dredge allowances are smaller today.
[23] Construction duration for DMM Scenario C is more uncertain than for the other two scenarios, because the decontamination technologies evaluated in DMM Scenario C have not been constructed and operated in the United States on a scale approaching the capacity needed for this alternative.

New Jersey's fish and crab consumption prohibitions and advisories would remain in effect (with enhanced outreach to increase awareness) until the remedial action objectives are met.

Because Alternative 2 with DMM Scenario A would result in hazardous substances, pollutants or contaminants remaining in the sediments above levels that would allow for unlimited use and unrestricted exposure (in Newark Bay CAD cells), CERCLA would require that five-year reviews be conducted. In addition, Alternative 2 under all DMM scenarios would require more than five years to achieve the remedial action objectives. Therefore, in accordance with EPA policy, five-year reviews would be conducted for Alternative 2, DMM Scenario B or C until the RAOs are achieved.

9.2.3. Alternative 3: Capping with Dredging for Flooding and Navigation

Present Value:	
With DMM Scenario A	$0.85 Billion
With DMM Scenario B	$1.38 Billion
With DMM Scenario C	$1.36 Billion
Construction Time:	6 years

Capping with Dredging for Flooding and Navigation is a bank-to-bank remedy that would place an engineered cap over the entire river bottom throughout the lower 8.3 miles of the Lower Passaic River. Before placement of the engineered cap, enough contaminated fine-grained sediment (3.5 million cy, based on an assumed cap thickness of 2 feet) would be dredged so that the cap could be placed without causing additional flooding and to allow for the continued use of the federally authorized navigation channel between RM 0 and RM 1.7.

This alternative includes dredging in portions of the 300-foot wide, federally authorized navigation channel to reasonably anticipated future use depths. The extent and depths of the navigation channel included in Alternative 3 as presented in the Proposed Plan were based on EPA's analysis of USACE's 2010 Lower Passaic River Navigation Analysis report and extensive consultation with USACE and NJDEP. In response to comments on the Proposed Plan, EPA reexamined available information pertaining to current and future commercial uses of the navigation channel submitted and obtained during the public comment period, as documented in the Responsiveness Summary (Appendix V). In further consultation with USACE and NJDEP, EPA has adjusted the extent and depths of the navigation channel included in Alternative 3 to the following: 30 feet MLW from RM 0 to RM 0.6 and 20 feet MLW from RM 0.6 to RM 1.7. Associated adjustments in dredging volume, construction duration and project costs were made and are presented in the ROD.

Where dredging depths coincide with the federally authorized navigation channel (RM 0 to RM 0.6), an additional 3 feet would be dredged to account for historical dredging accuracy and over-dredging. Because this action is expected to dredge all contaminated fine-grained sediments within the channel below RM 0.6, an engineered cap may not be required and a layer of backfill would be placed to mitigate the effect of dredging residuals. Between RM 0.6 and RM 1.7,

where dredging depths are shallower than the current federally authorized channel, an estimated 5.5 feet of sediment below the proposed channel depth would be dredged to accommodate an engineered cap; the additional depth provides for a cap protection buffer and allowance for future maintenance dredging. Resulting dredging depths (all in MLW) are shown in Table 28 in Appendix II.

Since some of the capped areas would be shallower than the federally authorized channel depths, it would be necessary to pursue both modification of the authorized depth (from RM 0.6 to RM 1.7) and deauthorization (from RM 1.7 to RM 8.3) of the federal navigation channel through Congressional action. USACE has advised that it will support such modification of authorized depths, and deauthorization of navigation channel.

Between RM 1.7 and RM 8.3, dredging would be performed to allow for the installation of an engineered cap without additional flooding and to accommodate reasonably anticipated recreational future uses. While commercial navigation is not an expected future use above RM 1.7, additional dredging is included in this alternative to account for the recreational uses discussed in Sections 6 and 8. Between RM 1.7 and RM 8.3, sufficient dredging would be performed to provide a depth of at least 10 feet below MLW over a designated 200-foot width (reduced to a 150-foot width between RM 8.1 and RM 8.3) to accommodate reasonably anticipated future recreational uses. Between RM 1.7 and RM 8.3, this would mean dredging approximately 2.5 feet below the existing sediment surface, with most of that depth necessary to prevent additional flooding due to the placement of the engineered cap and some smoothing of a few areas to achieve at least 10 feet below MLW. Final dredging depths may be refined in the remedial design to better account for flooding and recreational use, but still allow for enough dredging to ensure cap stability and integrity.

Dredged materials removed would be managed in accordance with one of three DMM scenarios described in Section 9.1.6. The construction time estimate (6 years) includes time for dredging, backfilling and dredged material disposal. The construction duration is driven by the time required for dredging and is not influenced by the choice of DMM scenario, because EPA assumes that the DMM facilities could be designed and constructed to manage the dredged material throughput without adding to the time needed.[24]

Mudflats dredged during implementation of Alternative 3 would be reconstructed to their original grade. The engineered cap over the mudflats would consist of 1 foot of sand and 1 foot of mudflat reconstruction substrate (but can vary depending on conditions) that would provide a suitable habitat to support current and expected future ecological uses. USACE habitat restoration plans for the New York-New Jersey Harbor Estuary could provide additional information on appropriate habitat reconstruction techniques.

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[24] Construction duration for DMM Scenario C is more uncertain than for the other two scenarios, because the decontamination technologies evaluated in DMM Scenario C have not been constructed and operated in the United States on a scale approaching the capacity needed for this alternative.

Institutional controls and monitoring would be implemented after construction. New Jersey's fish and crab consumption prohibitions and advisories would remain in effect (with enhanced outreach to increase awareness) until the remedial action objectives are met. Other permanent institutional controls are likely to include restrictions on activities that might disturb the engineered cap, as discussed in Section 9.1.1.

Because Alternative 3 would result in hazardous substances, pollutants or contaminants remaining in the sediments of the lower 8.3 miles above levels that would allow for unlimited use and unrestricted exposure, CERCLA would require that five-year reviews be conducted.

9.2.4. Alternative 4: Focused Capping, with Dredging for Flooding

Present Value:	
With DMM Scenario A	$0.36 Billion
With DMM Scenario B	$0.56 Billion
With DMM Scenario C	$0.59 Billion
Construction Time:	2.5 years

Focused or "hotspot" remedies are commonly considered for large sediment sites. To allow for an evaluation of whether a more focused approach to addressing the contaminated sediments of the lower 8.3 miles could meet the remedial action objectives, EPA evaluated an alternative consisting of dredging and capping the discrete areas of the lower 8.3 miles that EPA identified as releasing the most contaminants into the water column. Focused Capping with Dredging for Flooding includes dredging of contaminated fine-grained sediments (1 million cy) in selected portions of the lower 8.3 miles of the Lower Passaic River (cumulatively, approximately 220 acres or about one third of the lower 8.3-mile sediment surface) with the highest gross and net fluxes of COCs (see Figure 18[25] in Appendix I). These areas are those that have high surface concentrations of COCs and experience high erosional forces (i.e., shear stresses), so that this alternative accounts for the stability of the sediment bed and the mobility of contaminants within it, in accordance with EPA's December 2005 *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites*. Dredging would occur to a depth of about 2.5 feet to allow for installation of an engineered cap without causing additional flooding, as discussed in Alternative 3.

Alternative 4 would not include any dredging to accommodate the continued use of the channel for navigation, or to accommodate future recreational uses. Since some of the capped areas would be shallower than the federally authorized channel depths, it would be necessary to pursue deauthorization of those portions of the federal navigation channel through Congressional action.

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[25] In response to comments, EPA made various changes to the sediment transport and organic carbon-contaminant fate and transport models, as discussed in the Responsiveness Summary (Appendix V) and Attachment E. The updated models were used to identify areas in the lower 8.3 miles with the highest gross and net fluxes of COCs that are shown in Figure 18.

Dredged materials removed would be managed in accordance with one of three DMM scenarios described in Section 9.1.6. The construction time estimate (2.5 years) includes time for dredging, capping and dredged material disposal. The construction duration is driven by the time required for dredging and is not influenced by the choice of DMM scenario, because EPA assumes that the DMM facilities could be designed and constructed to manage dredged material throughput without adding to the time needed.

Mudflats dredged during implementation of Alternative 4 would be reconstructed to their original grade. The engineered cap over the mudflats would consist of 1 foot of sand and 1 foot of mudflat reconstruction (habitat) substrate, but can vary depending on conditions.

Institutional controls and monitoring would be implemented after construction. New Jersey's fish and crab consumption prohibitions and advisories would remain in effect (with enhanced outreach to increase awareness) until remedial action objectives are met. Other institutional controls would include restrictions on activities that could result in contact with uncapped sediments, or restrictions on activities that could disturb the engineered caps, as discussed in Section 9.1.1.

Because Alternative 4 would result in hazardous substances, pollutants or contaminants remaining in the sediments of the lower 8.3 miles above levels that would allow for unlimited use and unrestricted exposure, CERCLA would require that five-year reviews be conducted.

10. COMPARATIVE ANALYSIS OF ALTERNATIVES

In selecting a remedy, EPA considered the factors set out in CERCLA §121, 42 U.S.C. §9621, by conducting a detailed analysis of the viable remedial response measures pursuant to the NCP, 40 CFR §300.430(e)(9) and OSWER Directive 9355.3-01. The detailed analysis in the FFS Report consisted of an assessment of the individual response measures against each of the evaluation criteria. This section profiles the relative performance of each alternative against the nine criteria, noting how it compares to the other alternatives under consideration.

Threshold Criteria *- The first two criteria are known as "threshold criteria" because they are the minimum requirements that each response measure must meet to be eligible for selection as a remedy.*

10.1. Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled, through treatment, engineering controls, and/or institutional controls.

A primary requirement of CERCLA is that the selected remedial action be protective of human health and the environment. An alternative is protective if it reduces current and potential future risks associated with each exposure pathway at a site to acceptable levels for the human health and ecological receptors.

Alternative 1 (No Action) would not be protective of human health and the environment. Under Alternative 1, the resuspension and redeposition of contaminated sediments in the lower 8.3 miles of the Lower Passaic River would continue to contaminate the surface sediments and biota in the lower 8.3 miles, so that the unacceptable risks to humans and the environment calculated in the baseline risk assessment would continue in the future. Sediment data show that some decline in surface sediment concentrations is occurring over time due to natural recovery processes, although these processes have slowed considerably over approximately the past 15 to 20 years as the navigation channel has filled in and the river has begun to reach a quasi-steady state. Computer modeling results[26] for Alternative 1 show that the decline in concentrations is extremely slow, so that in the period of 2020 to 2046 (26-year period[27] chosen to allow comparison to the 26-year period after construction for the active alternatives), human health total cancer risk (sum for the adult and child for all COCs) would be 4×10^{-3} and 2×10^{-3} for fish and crab consumption, respectively; these levels exceed the acceptable risk range. The total noncancer health hazards for the adult would be 100 and 44 for fish and crab consumption, respectively, and for the child would be 194 and 84 for fish and crab consumption, respectively; these levels exceed the goal of protection of an HI equal to 1. By the end of the period 2020 to 2049 (30-year period chosen to allow comparison to the 30-year period after construction for the active alternatives), ecological HQs for benthic invertebrates would range from 0.1 to 200, with HQs for copper, mercury, Total PCBs and 2,3,7,8-TCDD exceeding 1; for fish would range from 0.1 to 200, with HQs for copper, Total PCBs and dioxins/furans exceeding 1; and for wildlife would range from 0.07 to 200, with HQs for lead in birds exceeding 1 and HQs for mercury, total PCBs, dioxin-like PCBs and dioxins/furans in mammals exceeding 1.

Alternative 2 and 3 would replace the highly contaminated riverbed of the lower 8.3 miles with effectively clean material (sand), bank to bank. There is no more comprehensive way to remediate the sediments of the lower 8.3 miles. EPA's modeling results show that, after the sand is placed bank-to-bank in the lower 8.3 miles, incoming COCs from above Dundee Dam, from Newark Bay and from the Lower Passaic River above RM 8.3 will gradually recontaminate the new riverbed surface. EPA's model underestimates the effectiveness of the bank-to-bank remedies because, while the model assumes that the incoming COCs will remain constant until

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[26] As noted in footnote 25, in response to comments, EPA made various changes to the sediment transport and organic carbon-contaminant fate and transport models, as discussed in the Responsiveness Summary (Appendix V) and Attachment E. Throughout the ROD, where model results are discussed, EPA is referring to the updated model results.

[27] As discussed in Section 7.1.2.4, the 2014 updated Standard Default Exposure Assumptions, released after the RI/FFS was completed, changed the adult ED from 24 years to 20 years and the total ED from 30 years to 26 years. In response to comments, EPA updated the risk estimates and other related analyses with the updated EDs, including the modeling period over which future human health risk reductions are compared. The 2014 updates did not affect the ecological risk assessment, so that the modeling period over which future ecological risk reductions are compared remains 30 years, the same as used in the Proposed Plan.

the end of the simulation period (until the early 2060s), EPA expects that those COCs will decline over time as the Lower Passaic River above RM 8.3 and Newark Bay are remediated through actions selected under CERCLA. Furthermore, EPA expects that Clean Water Act programs will address COCs coming in from above Dundee Dam. Such actions, taken while the remedy for the lower 8.3 miles is being designed and implemented, will reduce the incoming COCs and minimize the degree of recontamination, allowing the bank-to-bank remedies (Alternatives 2 and 3) to achieve protectiveness by achieving the cancer risk range of 10^{-4} to 10^{-6}, noncancer HIs equal to or less than 1 and ecological HQs equal to or less than 1.

Alternative 2 (Deep Dredging with Backfill) and Alternative 3 (Capping with Dredging for Flooding and Navigation) would both protect human health and the environment to approximately to the same degree, because both would result in the remediation of surface sediments bank to bank in the lower 8.3 miles, and those lower 8.3-mile surface sediments would be subjected to similar levels of recontamination from the influx, mixing and deposition of sediment that enters from above Dundee Dam, from between the dam and RM 8.3, and from Newark Bay. The sediments of the lower 8.3 miles of the Lower Passaic River are currently a major source of COCs to the river above RM 8.3 and to Newark Bay. Addressing the sediments in the lower 8.3 miles by dredging or capping bank to bank would eliminate a major source of contamination to the rest of the Lower Passaic River and Newark Bay, thereby reducing the contamination brought back into the lower 8.3 miles from those areas over time.

Alternative 2 would address the unacceptable risks and hazards due to COCs in the lower 8.3-mile sediments by removing the extensive inventory of contaminated fine-grained sediments from RM 0 to RM 8.3 (approximately 9.7 million cy). Dredging residuals that remain in the lower 8.3 miles after construction would be covered by a 2-foot layer of backfill.

- For just dioxins/furans, computer models predict that implementation of Alternative 2 would reduce risks so that in the 26-year period after construction (2034 to 2059), the human health total cancer risk (for the adult and child) would be 5×10^{-5} and 2×10^{-5} for fish and crab consumption, respectively. The noncancer health hazard for the adult would be 1 and 0.4 for fish and crab consumption, respectively, and for the child would be 2 and 0.8 for fish and crab consumption, respectively.
- For all human health COCs (dioxins/furans, PCBs and mercury) combined, computer models predict that the human health total cancer risk (for the adult and child for all COCs) would be 5×10^{-4} and 4×10^{-4} for fish and crab consumption, respectively, in the 26-year period after construction. The noncancer health hazard for the adult would be 13 and 9 for fish and crab consumption, respectively, and for the child would be 24 and 17 for fish and crab consumption, respectively. The computer models show that recontamination from dioxin-like PCBs is a primary reason that risks and hazards rise gradually over time from the lowest levels achieved upon construction completion, such that in the 26-year period after construction, risks and hazards exceed the acceptable risk range and HI of 1. The risks and hazards would be above EPA's goals, so Alternative 2 would incorporate institutional controls such as fish and crab consumption prohibitions and advisories enhanced by additional outreach to ensure protectiveness.

For the ecological COCs, thirty years after construction (2063), ecological HQs for benthic invertebrates would range from 0.05 to 8, with HQs for mercury, Total PCBs and 2,3,7,8-TCDD exceeding 1; for fish would range from 0.08 to 8, with HQs for copper and dioxins/furans exceeding 1; and for wildlife would range from 0.02 to 7, with HQs for mercury, total PCBs, dioxin-like PCBs and dioxins/furans in mammals exceeding 1.

Alternative 3 would address the unacceptable risks due to COCs in the sediments of the lower 8.3 miles of the Lower Passaic River by sequestering the extensive inventory of contaminated sediments in the lower 8.3 miles under a bank-to-bank engineered cap.

- For just dioxins/furans, computer models predict that implementation of Alternative 3 would reduce risks so that in the 26-year period after construction (2026 to 2051), the human health total cancer risk (for the adult and child) would be 6×10^{-5} and 2×10^{-5} for fish and crab consumption, respectively. The noncancer health hazard for the adult would be 1 and 0.5 for fish and crab consumption, respectively, and for the child would be 2 and 1 for fish and crab consumption, respectively.
- For all human health COCs (dioxins/furans, PCBs and mercury) combined, computer models predict that the human health total cancer risk (for the adult and child for all COCs) would be 5×10^{-4} and 4×10^{-4} for fish and crab consumption, respectively. The noncancer health hazard for the adult would be 14 and 10 for fish and crab consumption, respectively, and for the child would be 29 and 20 for fish and crab consumption, respectively. The computer models show that recontamination from dioxin-like PCBs is a primary reason that risks and hazards rise gradually over time from the lowest levels achieved upon construction completion, such that in the 26-year period after construction, risks and hazards exceed the acceptable risk range and HI of 1. Risks and hazards would be above EPA's goals, so Alternative 3 would incorporate institutional controls such as fish and crab consumption prohibitions and advisories enhanced by additional outreach to ensure protectiveness.

For ecological COCs, thirty years after construction (2055), ecological HQs for benthic invertebrates would range from 0.05 to 9, with HQs for mercury, Total PCBs and 2,3,7,8-TCDD exceeding 1; for fish would range from 0.08 to 10, with HQs for copper and dioxins/furans exceeding 1; and for wildlife would range from 0.02 to 9, with HQs for mercury, total PCBs, dioxin-like PCBs and dioxins/furans in mammals exceeding 1.

As discussed above, EPA's model underestimates the effectiveness of the bank-to-bank remedies because it does not account for any reduction in incoming COCs over time as the Lower Passaic River above RM 8.3 and Newark Bay are remediated under the Superfund program and COCs from above Dundee Dam are addressed under Clean Water Act programs. Such actions, taken while the remedy for the lower 8.3 miles is being designed and implemented, will reduce the incoming COCs and minimize the degree of recontamination, allowing the bank-to-bank remedies (Alternatives 2 and 3) to achieve protectiveness.

Alternative 4 (Focused Capping with Dredging for Flooding) would address the unacceptable risks due to COCs in lower 8.3-mile sediments to some extent by capping the areas that contribute the most contaminant flux to the water column; the discrete areas of sediments to be capped would add up to about one-third of the surface of the lower 8.3 miles of the Lower Passaic River. Computer models predict that implementation of Alternative 4 would reduce risks, so that in the 26-year period after construction (2023 to 2048), human health total cancer risk (for adult and child for all COCs) would be 1×10^{-3} and 7×10^{-4} for fish and crab consumption, respectively. The noncancer health hazard for the adult would be 33 and 17 for fish and crab consumption, respectively, and for the child would be 68 and 34 for fish and crab consumption, respectively. The noncancer health hazards would be above EPA's goal of an HI of 1, so Alternative 4 would incorporate institutional controls such as fish and crab consumption prohibitions and advisories enhanced by additional outreach to ensure protectiveness. Thirty years after construction (2052), ecological HQs for benthic invertebrates would range from 0.08 to 20, with HQs for mercury, Total PCBs and 2,3,7,8-TCDD exceeding 1; for fish would range from 0.09 to 30, with HQs for copper and dioxins/furans exceeding 1; and for wildlife would range from 0.04 to 30, with HQs for mercury, total PCBs, dioxin-like PCBs and dioxins/furans in mammals exceeding 1.

EPA's computer model predicts that, 26 to 30 years post-remediation, the cancer risks, noncancer health hazards and ecological risks achieved by Alternative 4 are higher than those achieved by Alternatives 2 and 3. Those predictions are consistent with the body of data collected over the past 20 years and the conceptual understanding of the river system presented under Section 5. The data show that lower 8.3-mile surface sediments have average COC concentrations that are almost 100 times higher than the remediation goals. Given the ubiquitous nature of highly contaminated sediments in the lower 8.3 miles, capping discrete areas totaling about one-third of the lower 8.3 miles is unlikely to lead to decreases in COC concentrations equal to or greater than those that would be achieved by bank-to-bank remediation. Even though the sediment areas evaluated for capping in Alternative 4 are those that contribute the most contaminant flux to the water column, the contaminated sediments in the remaining two-thirds of the lower 8.3 miles not addressed by Alternative 4 still include elevated concentrations of COCs that would contribute to risk by remaining in place, potentially being resuspended with the tide or in storm events to recontaminate the adjacent capped areas. While EPA's model also underestimates the effectiveness of Alternative 4, because it does not account for any reduction in incoming COCs over time, the effect of recontamination on the protectiveness of Alternative 4 includes and is greatly exacerbated by the resuspension of highly contaminated sediments from the unremediated two-thirds of the lower 8.3-mile riverbed redepositing on adjacent capped areas. While EPA actions under the Superfund and Clean Water Act programs may reduce the incoming COCs in the future, the resuspension of highly contaminated sediments from the unremediated two-thirds of the lower 8.3 miles will continue unabated.

Under Alternatives 2, 3 and 4, for DMM Scenario A (CAD), an engineered cap would be placed over the CAD cells in Newark Bay and the cap would be monitored and maintained in perpetuity. In consultations prior to the release of the Proposed Plan, the State of New Jersey, NOAA and USFWS, in their roles as natural resource trustees, expressed serious concerns about

the disposal of highly contaminated sediment from the Lower Passaic River into a CAD cell in Newark Bay and the associated potential impacts to the aquatic environment. An additional concern of the Trustees was the scale and footprint of the CAD cells that would be required, which would be substantially larger than other CAD cells sited for environmental remediation in other waters of the United States.

These concerns are discussed further in Section 10.5, because EPA has analyzed these impacts as short-term, temporary impacts during remedy construction. However, NOAA has advised EPA that the presence of open CAD cells in Newark Bay for 2.5 to 14 years, as EPA calculated would be necessary under the three active alternatives, could have long-term impacts on some species that are dependent on limited bay bottom habitat for critical life stages. In contrast, DMM Scenarios B (Off-Site Disposal) and C (Local Decontamination and Beneficial Use) have no comparable environmental impact on the aquatic environment of Newark Bay.

10.2. Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

Section 121 (d) of CERCLA and NCP §300.430(f)(1)(ii)(B) require that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria, and limitations which are collectively referred to as "ARARs," unless such ARARs are waived under CERCLA section 121(d)(4). Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those State standards identified by a state in a timely manner and that are more stringent than Federal requirements may be applicable.

Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site. Only those State standards that are identified in a timely manner and are more stringent than Federal requirements may be relevant and appropriate.

Compliance with ARARs addresses whether a remedy will meet all of the applicable or relevant and appropriate requirements of other Federal and State environmental statutes or provides a basis for invoking a waiver.

Any alternative considered by EPA must comply with all federal and state environmental standards, requirements, criteria or limitations, unless they are waived under certain specific conditions.

Alternative 1 (No Action) would not contribute toward eventual achievement of federal and state surface water ARARs. Since there is no active remediation associated with this alternative, action-specific and location-specific ARARs do not apply.

Compliance with surface water quality ARARs is both a short-term requirement during remediation and a long-term requirement after the remediation at the Diamond Alkali Site, including in the Lower Passaic River and Newark Bay, is completed. In the short term, actions would be taken during the implementation of Alternatives 2 (Deep Dredging with Backfill), 3 (Capping with Dredging for Flooding and Navigation) and 4 (Focused Capping with Dredging for Flooding) to reduce construction-related surface water quality impacts. Alternatives 2, 3 and 4 are designed to address sediment contamination in the lower 8.3 miles of the Lower Passaic River. Although remediation of contaminated sediment would contribute to improved water quality, implementation of any of these alternatives, by itself, would be unlikely to achieve compliance with ARARs in the water column. However, because this ROD only addresses the sediment portion of the lower 8.3 miles and is an interim action for the water column, and is only part of the remedial activities under consideration for the 17-mile Lower Passaic River and Newark Bay, compliance with surface water ARARs would more likely be achieved and therefore more appropriately addressed after additional response actions have been implemented.

Alternatives 2, 3 and 4 would satisfy the location-specific and action-specific ARARs, such as the requirements of the Clean Water Act that would apply to dredging and the RCRA requirements that would apply to management of dredged materials. Alternatives 2, 3 and 4, which include placement of material on the river bottom, would need to be implemented in compliance with the Clean Water Act, 33 U.S.C. §404(b)(1) and 40 CFR Part 230, which require that disturbance to aquatic habitat be minimized to the extent possible. Compliance with the substantive elements of New Jersey Flood Hazard Control Act Rules, including those addressing placement of material in the flood hazard area and impacts to riparian zones would also be required.

Alternative 3 includes capping within the federally authorized navigation channel without enough dredging to accommodate the authorized depth from RM 0.6 to RM 8.3. In order to comply with Section 10 the Rivers and Harbors Act (33 U.S.C. § 403), which is a location-specific ARAR, as well as the navigation channel depths authorized by Congress, Alternative 3 would require both modification of the Congressionally-authorized navigation channel depths (from RM 0.6 to RM 1.7) and deauthorization of the navigation channel (from RM 1.7 to RM 8.3) through Congressional action. As discussed in Section 8, USACE has advised that it will support recommendations to Congress to accomplish these changes.

Alternative 4 includes capping within portions of the federally authorized navigation channel, without any dredging to accommodate the authorized depth in areas of the river between approximately RM 2.7 to RM 8.3. In order to comply with Section 10 of the Rivers and Harbors Act, Alternative 4 would require de-authorization of the federal navigation channel from

approximately RM 2.7 to RM 8.3 through Congressional action. Since USACE has advised that it will support a recommendation for Congressional action to deauthorize the federal navigation channel from RM 1.7 to RM 8.3, USACE would likely also support the recommendation for Congressional action required for Alternative 4.

A complete list of ARARs can be found in Table 29 in Appendix II.

Primary Balancing Criteria *- The next five criteria, criteria 3 through 7, are known as "primary balancing criteria." These criteria involve the assessment of factors between response measures so that the best option will be chosen, given site-specific data and conditions.*

10.3. Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once clean-up levels have been met. This criterion includes the consideration of residual risk that will remain on site following remediation and the adequacy and reliability of controls.

Alternative 1 (No Action) would not be effective in addressing the contaminated sediments that are causing the unacceptable risks identified in the baseline risk assessments. Natural recovery processes would cause some decline in surface sediment concentrations over time. Computer modeling results (see Figures 19, 20, 21 and 22 in Appendix I) for Alternative 1 show that, by the early 2060s (end of the model simulation period), surface sediment concentrations in the lower 8.3 miles of the Lower Passaic River would remain above all of the remediation goals for any COC.

- For dioxin, by the early 2060s, lower 8.3-mile surface sediment concentrations are predicted to reach approximately 0.5 ug/kg or ppb (micrograms per kilogram or parts per billion), which is over 60 times higher than the remediation goal.
- For PCBs, by the early 2060s, lower 8.3-mile surface sediment concentrations are predicted to reach approximately 920 ug/kg or ppb, which is almost 20 times higher than the remediation goal.
- For mercury, by the early 2060s, lower 8.3-mile surface sediment concentrations are predicted to reach approximately 2000 ug/kg or ppb, which is almost 30 times higher than the remediation goal.
- For Total DDx, by the early 2060s, lower 8.3-mile surface sediment concentrations are predicted to reach approximately 90 ug/kg or ppb, which is approximately 300 times higher than the remediation goal.

Alternative 1 (No Action) would not include any containment systems and would not rely on institutional controls to address COC contamination in lower 8.3-mile sediments.

Under Alternative 2 (Deep Dredging with Backfill), approximately 9.7 million cy of contaminated sediments covering approximately 650 acres of river bottom between RM 0 and RM 8.3 would be permanently removed from the ecosystem of the Lower Passaic River after construction is completed. Dredging residuals remaining in the lower 8.3 miles would be covered by a layer of backfill. Under Alternative 3 (Capping with Dredging for Flooding and Navigation), approximately 3.5 million cy of contaminated sediments covering approximately 650 acres of river bottom between RM 0 and RM 8.3 would be permanently removed from the ecosystem of the Lower Passaic River, followed by construction of a two-foot engineered cap (or placement of backfill where appropriate) over the entire lower 8.3 miles. A significant decline in surface sediment concentrations in the lower 8.3 miles is predicted for COCs under both alternatives (see Figures 19, 20, 21 and 22 in Appendix I).

- For dioxin, by the early 2060s, lower 8.3-mile surface sediment concentrations are predicted to reach approximately 0.01 ppb for Alternatives 2 and 3, which is approximately at the remediation goal.
- For PCBs, by the early 2060s, lower 8.3-mile surface sediment concentrations are predicted to reach approximately 200 ppb (Alternative 2) and 260 ppb (Alternative 3), which are approximately four and six times higher than the remediation goal, respectively.
- For mercury, by the early 2060s, lower 8.3-mile surface sediment concentrations are predicted to reach approximately 700 ppb for Alternatives 2 and 3, which is approximately ten times higher than the remediation goal.
- For Total DDx, by the early 2060s, lower 8.3-mile surface sediment concentrations are predicted to reach approximately 30 ppb for Alternatives 2 and 3, which is approximately 100 times higher than the remediation goal.

Alternatives 2 and 3 would incorporate fish and crab consumption prohibitions and advisories to ensure protectiveness of human health. EPA's modeling predicts that for dioxin and PCBs, shortly after construction completion, lower 8.3-mile surface sediment concentrations would reach the interim remediation milestones that correspond to interim protective fish and crab tissue concentrations, sufficiently protective to potentially allow NJDEP to consider lifting or relaxing the stringency of prohibitions on fish and crab consumption (e.g., allowing one fish meal per month, as opposed to the current prohibitions on consumption of fish or crab from the Lower Passaic River).

EPA's modeling of each of the alternatives predicted that in order to achieve COC concentrations approaching as closely as possible to remediation goals, bank-to-bank remediation in the lower 8.3 miles is necessary. Modeling results also predicted that bank-to-bank alternatives would reduce surface sediment concentrations for some of the COCs to below background levels in the future. This is because sediment particles coming over Dundee Dam make up only about one third of recently deposited sediment in the lower 8.3 miles, and when those particles flow down to the lower 8.3 miles, they mix with the other particles in the system (including cleaner particles in the water column that would result from a remediated lower 8.3 miles). The model took into consideration this mixing of newly arriving background

contamination with clean material introduced as part of the remedy and predicted that the top six inches (the bioactive zone) could be less contaminated post-remediation than the background concentrations coming over Dundee Dam.

EPA's modeling results also show that, after bank-to-bank remediation of the lower 8.3 miles, incoming COCs from above Dundee Dam, from Newark Bay and from the Lower Passaic River above RM 8.3 will gradually recontaminate the new riverbed surface. EPA's model underestimates the effectiveness of the bank-to-bank remedies because, while the model assumes that the incoming COCs will remain constant until the end of the simulation period (until the early 2060s), EPA expects that those COCs will decline over time as the Lower Passaic River above RM 8.3 and Newark Bay are remediated through actions selected after the completion of the 17-mile RI/FS and Newark Bay RI/FS, respectively, and Clean Water Act programs will address COCs from above Dundee Dam. Such actions, taken while the remedy for the lower 8.3 miles is being designed and implemented, will reduce the incoming COCs and minimize the degree of recontamination, allowing the bank-to-bank remedies (Alternatives 2 and 3) to achieve protectiveness.

Alternative 2 would not rely on a containment system to maintain protectiveness in the lower 8.3 miles of the Lower Passaic River over the long term, since the contaminated fine-grained sediments would be removed. Note that a containment system (i.e., CAD cells in Newark Bay) was considered as one of the DMM scenarios for this alternative (see below).

Alternative 3 would be effective in the long term in limiting exposure to risks posed by COCs in the lower 8.3-mile sediments provided the integrity of the engineered cap is maintained. Therefore, the cap would need to be monitored and maintained in perpetuity. Engineered caps have been demonstrated to be effective over the long term in sequestering contaminated sediments at other Superfund sites, when they are properly designed and maintained. For cost-estimation purposes, the engineered cap for the lower 8.3 miles was assumed to consist of sand with a grain size large enough to withstand a 100-year storm with less than 3 inches of erosion (a fraction of the cap's thickness), thus minimizing the likelihood that cap integrity would be compromised during a storm event or season. Certain areas of the river were assumed to need armoring for further protection against erosion. The cost estimate also assumed periodic cap inspections and necessary maintenance at regular intervals and after storm events.

For Alternative 4 (Focused Capping with Dredging for Flooding), approximately 1.0 million cy of contaminated sediments in discrete areas totaling approximately 220 acres of river bottom between RM 0 and RM 8.3 would be permanently removed, followed by placement of a two-foot engineered cap over those areas dredged. As discussed in Section 10.1, Alternative 4 would not achieve as much risk reduction as Alternatives 2 and 3, because the contaminated surface sediments in the two-thirds of the lower 8.3 miles of the Lower Passaic River that remain unaddressed would contribute to risk by remaining in place and would recontaminate adjacent capped areas. Computer modeling results (see Figures 19, 20, 21 and 22 in Appendix I) show that, by the early 2060s (end of the model simulation period), lower 8.3-mile surface sediment concentrations would remain above the remediation goals.

- For dioxin, by the early 2060s, lower 8.3-mile surface sediment concentrations are predicted to reach approximately 0.05 ppb, over six times higher than the remediation goal.
- For PCBs, by the early 2060s, lower 8.3-mile surface sediment concentrations are predicted to reach approximately 400 ppb, approximately 8 times higher than the remediation goals.
- For mercury, by the early 2060s, lower 8.3-mile surface sediment concentrations are predicted to reach approximately 1200 ppb, almost 20 times higher than the remediation goal.
- For Total DDx, by the early 2060s, lower 8.3-mile surface sediment concentrations are predicted to reach approximately 45 ppb, approximately 150 times higher than the remediation goals.

EPA's modeling predicts that, for dioxin and PCBs, shortly after construction completion for Alternative 4, lower 8.3-mile surface sediment concentrations would be reduced below the first interim remediation milestone corresponding to tissue concentrations that would allow adult anglers to eat 12 eight-ounce fish or crab meals per year at a 10^{-4} cancer risk level. However, the noncancer hazard would still be too great for NJDEP to consider lifting or relaxing the stringency of prohibitions on fish and crab consumption. Although, by the early 2060s, dioxin surface sediment concentrations are predicted to reach the interim remediation milestone corresponding to tissue concentrations that would allow adult anglers to eat 12 eight-ounce fish or crab meals per year at an HI equal to 1, PCB surface sediment concentrations are not predicted to be reduced enough to achieve any other interim remediation milestones or remediation goals.

The protectiveness of Alternative 4 depends on the ability to accurately identify the discrete areas that release the most contaminants into the water column and need to be addressed by dredging and capping. A great degree of uncertainty is associated with this process, as a result of the complex estuarine environment of the lower 8.3 miles. In addition, while EPA's model also underestimates the effectiveness of Alternative 4, because it does not account for any reduction in incoming COCs over time, the effect of recontamination on the protectiveness of Alternative 4 includes and is greatly exacerbated by the resuspension of highly contaminated sediments from the unremediated two-thirds of the lower 8.3-mile riverbed redepositing on adjacent capped areas. While EPA actions under the Superfund and Clean Water Act programs may reduce the incoming COCs in the future, the resuspension of highly contaminated sediments from the unremediated two-thirds of the lower 8.3 miles will continue unabated.

For Alternatives 2, 3 and 4, under DMM Scenario A (CAD), the engineered caps over the CAD cells would have to be monitored and maintained in perpetuity in order to ensure that this disposal method remained protective of human health and the environment over time. In contrast, there is no such requirement for DMM Scenario B (Off-Site Disposal) or DMM Scenario C (Local Decontamination and Beneficial Use), because existing landfills already have provisions for long-term monitoring and maintenance by landfill owners and operators.

DMM Scenario B relies on off-site treatment facilities (at this time, incinerators) and landfills which are in operation and have proven to be reliable technologies. The reliability of local decontamination technologies (DMM Scenario C), such as thermal treatment and sediment washing, is more uncertain since they have not been built and operated in the United States on a scale approaching the capacity needed for this project. In addition, sediment washing may be less effective when the matrix contains multiple contaminants and consists of a large proportion of finer particles like silts and clays as is true of Lower Passaic River sediments. Multiple treatment passes may be needed under such conditions.

10.4. Reduction of Toxicity, Mobility, or Volume of Contaminants Through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

This criterion addresses the statutory preference for selecting remedial actions that employ treatment technologies that permanently and/or significantly reduce the toxicity, mobility or volume of hazardous substances as their principal element.

For Alternative 1 (No Action), there would be no reduction of toxicity, mobility or volume through treatment.

For the active alternatives, reduction of mobility and volume of contaminated sediments in the lower 8.3 miles of the Lower Passaic River would be achieved by dredging and capping, not through treatment. The ultimate reduction of toxicity, mobility and volume for the sediments removed from the lower 8.3 miles depends on the DMM Scenario selected. Alternative 2 (Deep Dredging with Backfill), would result in removal of 9.7 million cy of contaminated sediments by dredging, followed by 3.5 million cy for Alternative 3, and 1 million cy for Alternative 4. By removing nearly three times as much sediment volume from the riverbed as the next nearest alternative, Alternative 2 will result in substantially more treatment overall under either of the DMM scenarios that include treatment. If, as discussed in Section 9.1.3, EPA were to identify an enhanced capping technology that included additives to create a reactive cap for use in some areas of the lower 8.3 miles, Alternatives 3 and 4 might include some *in situ* treatment.

For Alternatives 2, 3 and 4, under DMM Scenario A (CAD), the mobility of the COCs removed from the lower 8.3 miles of the Lower Passaic River would be effectively eliminated not through treatment, but by sequestering the dredged sediments in CAD cells under an engineered cap that would need to be monitored and maintained in perpetuity. There would be no reduction in toxicity, mobility or volume of the COCs through treatment.

Under DMM Scenario B (Off-Site Disposal), RCRA land disposal requirements will result in treatment of some dredged sediment through incineration that would reduce the toxicity, mobility and volume of the COCs removed from the lower 8.3 miles of the Lower Passaic River. Under DMM Scenario B, Alternative 2 is expected to treat the largest volume of Site

contaminants, followed by Alternative 3, then Alternative 4. Amounts to be incinerated or landfilled are estimated in Table 30 in Appendix II, although actual distributions between the two categories would depend on the results of characterization for disposal.

Under DMM Scenario C (Local Decontamination and Beneficial Use), thermal treatment and sediment washing would reduce the toxicity, mobility, and volume of the COCs removed from the lower 8.3 miles of the Lower Passaic River through treatment, while stabilization would reduce mobility through treatment without reducing toxicity or volume. Because DMM Scenario C anticipates treatment for nearly all the dredged sediments (regardless of which alternative is selected), it performs best under this evaluation criterion. Amounts to be treated under each technology are estimated in Table 31 in Appendix II, although actual distributions between the three treatment categories would depend on the results of characterization for disposal.

10.5. Short-Term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community and the environment during construction and operation of the remedy until cleanup levels are achieved.

This criterion addresses the effects of each alternative during construction and implementation until RAOs are met. It considers risks to the community, on-site workers and the environment, available mitigation measures and time frame for achieving the response objectives.

10.5.1. Short-Term Effectiveness: Potential Adverse Impacts on Communities and Workers During In-River Construction

The impacts due to construction in the river are mainly driven by the volume dredged and duration of construction for each alternative. Alternative 1 would not involve any construction that would present a risk to the community or workers. Implementation of Alternative 2 would have larger impacts on the community and workers than Alternative 3, because construction would last longer (14 years) and would involve handling of a larger volume of contaminated sediments (9.7 million cy). Implementation of Alternative 3 would have less of an impact on the community, workers and the environment than Alternative 2, although those impacts would still be important to mitigate, since the construction period would last 6 years and would involve handling of 3.5 million cy of contaminated sediments. Alternative 4 would also cause adverse impacts on the community, workers and the environment during construction, but those impacts would be smaller than those caused by Alternatives 2 and 3, because of the relatively short construction period (2.5 years) and smaller volume of contaminated sediments handled (1.0 million cy) relative to Alternatives 2 and 3.

Impacts to communities from construction of Alternatives 2, 3 and 4 would include temporary noise, light, odors, blocked views, traffic, potential air quality impacts and disruptions to commercial and recreational river users in the lower 8.3 miles of the Lower Passaic River (operating for a few months at a given location). These impacts could be lessened through use of

best management practices documented in community health and safety plans, but disruptions would still be significant, since dredging and backfilling or capping is expected to proceed 24 hours a day, six days per week and 32 weeks per year.

Potential occupational risks to site workers from construction of Alternatives 2, 3 and 4 could include direct contact, ingestion and inhalation of COCs from the surface water and sediments and routine physical hazards associated with construction work and working on water. Measures to minimize and mitigate such risks would be addressed in worker health and safety plans, by the use of best management practices and by following properly approved health and safety procedures.

10.5.2. Short-Term Effectiveness: Potential Adverse Impacts on the Environment During In-River Construction

Under Alternatives 2, 3 and 4, dredging would result in resuspension of contaminated sediments, which would cause fish and other organisms in the water to be exposed to higher concentrations of contaminants than are usually present in the water column. Studies have shown that dredging can result in resuspension loss of 1 percent to 3 percent of the material removed. The volume dredged under each alternative and the concentrations of contaminants on the resuspended sediments drive this adverse impact. Alternative 2 would have the most impact on the environment when compared to Alternatives 3 and 4, because Alternative 2 would have the largest volume dredged, and the deepest dredging into the sediment bed where contaminant concentrations are highest, leading to the greatest mass of COCs released through dredging over the longest construction period (14 years, as opposed to 6 years for Alternative 3 and 2.5 years for Alternative 4). Alternative 3 would have less impact on the environment than Alternative 2, but more than Alternative 4.

Risks due to resuspension could be minimized through proper equipment selection, control of sediment removal rates (through careful operation of the dredging equipment) and the application of best management practices in all in-river operations. Environmental impacts from construction would include temporary loss of benthos and habitat for the ecological community in dredged areas and in areas affected by resuspension of contaminated sediments during dredging. Habitat replacement measures would be implemented to mitigate these impacts. Since the remedial action would improve and replace existing open water, mudflat and intertidal habitat, no additional compensatory mitigation measures would be necessary for this aspect of the remediation. Natural benthic re-colonization following a disturbance is usually fairly rapid, and can begin within days after perturbation. In many cases, full recovery to pre-disturbance species composition and abundance occurs within a few years.

10.5.3. Short-Term Effectiveness: Impacts on Communities, Workers and the Environment from Disposal Options

The impacts associated with the disposal options are mainly driven by the mode of transportation for the dredged materials and amount of local processing of dredged materials.

For Alternatives 2, 3 and 4, under DMM Scenario A (CAD), EPA assumed that the CAD cells would be sited in the part of Newark Bay where the thickest layer of clay (approximately 60 feet) is likely to be found. Dredged materials from the lower 8.3 miles of the Lower Passaic River would be barged to the Newark Bay CAD site so an upland sediment processing facility on the banks of the Lower Passaic River or Newark Bay would not be necessary. This would minimize on-land impacts to the community, but increase traffic in the bay. Since major container terminals are located in Newark Bay near the CAD sites that EPA considered in the FFS, increased barge traffic to and from the CAD site may interfere with existing port commercial traffic and increase the potential for waterborne commerce accidents. Depending on the alternative, EPA estimates that approximately 2 to 4 barges a day would be needed to transport dredged materials from the lower 8.3 miles of the Lower Passaic River to a CAD site in Newark Bay, which would increase vessel traffic from the Lower Passaic River to Newark Bay by approximately 50 percent compared to current conditions documented in USACE's *Waterborne Commerce Statistics*.

While dredged materials would also have to be barged or pumped to an upland processing facility under DMM Scenarios B (Off-Site Disposal) or C (Local Decontamination and Beneficial Use), an FFS-level survey of land along the shoreline of the lower 8.3 miles of the Lower Passaic River and Newark Bay showed a number of locations suitable for an upland processing facility. Siting the upland processing facility adjacent to the shoreline within the area to be dredged would minimize the impact of increased in-water traffic associated with DMM Scenarios B and C and avoid interference with the major container terminals in Newark Bay to the extent possible.

DMM Scenarios B and C would cause more on-land impacts to the local community and workers compared to DMM Scenario A. These disposal options would require the siting of a 29- to 38-acre (depending on the alternative and scenario) upland sediment processing facility on or near the banks of the Lower Passaic River or Newark Bay. For cost and schedule-estimation purposes, the facility was assumed to operate for 24 hours a day, 6 days a week, 32 weeks[28] each year for 2.5 to 14 years (depending on the alternative). Best efforts to minimize impacts on the local community and workers would be implemented; however, operation of the facility would still result in more odors, noise, light pollution, potential air quality impacts, greater risk of accidents from equipment operation and increased traffic on local roads than DMM Scenario A, which does not need an upland sediment processing facility. DMM Scenario B would have less impact on the local community and workers than DMM Scenario C, because DMM Scenario B involves less processing of dredged materials at the upland processing facility than DMM Scenario C. For DMM Scenario B, only coarse material separation and dewatering would need to be performed at the upland processing facility before materials are loaded onto rail cars and shipped off site to a RCRA permitted disposal facility. For DMM Scenario C, material

[28] For cost and schedule estimation purposes, dredging and capping or backfill was assumed to occur for 32 weeks a year. Within the 35-week construction season discussed in the Responsiveness Summary (Appendix V), three non-consecutive weeks of downtime for equipment maintenance and weather-related downtime were assumed, since such events cannot be predicted.

separation, dewatering, thermal treatment, sediment washing and solidification/stabilization would occur at the upland processing facility before the beneficial use end-products are loaded into trucks or railcars to be sent to their final destination. Less processing of dredged materials at the upland processing facility means less equipment operating for the duration of the project and a smaller footprint for the upland processing facility. Measures to minimize and mitigate impacts on the community would be addressed in community health and safety plans, and by the use of best management practices.

Under DMM Scenario A, construction and operation of the CAD site could have substantial impacts on the aquatic environment, some of which could be lessened through engineering controls. Computer simulations of CAD cells placed in Newark Bay and operated without any dissolved- and particulate-phase controls were modeled over short time periods. Modeling results indicated contaminant losses from the CAD cells of approximately 1 percent of the mass placed, even over the short time period modeled (seven days), and assuming placement of a small amount of dredged materials in the CAD site (approximately 38,400 cy). Based on these modeling results, the CAD site conceptual design used for developing DMM Scenario A in the FFS includes sheet pile walls on all sides and a silt curtain across the entrance channel, intended to lessen the migration of dissolved and particulate-phase contaminants out of the CAD cells during construction and operation. Even with the use of sheet pile walls and a silt curtain, some of the dissolved-phase contamination could still escape during dredged material disposal.

Intertidal and subtidal shallows, such as those where CAD cells would be located, provide valuable habitat for various aquatic species, including areas designated by NOAA as Essential Fish Habitat.

In a letter dated March 10, 2014, the Federal Trustees urged EPA not to consider alternatives that include disposal of contaminated sediment into the waters of Newark Bay. They explained that a CAD cell in this situation would be unprecedented in terms of the potential for adverse effects to aquatic habitat, the high concentrations of contaminants, the volume of sediment and the footprint (acres) of the CAD cell. They observed that some species (particularly winter flounder) use the Bay bottom to lay their eggs and will not spawn if those areas are disturbed or not accessible. Young-of-the-year flounder tend to burrow in the sediment rather than swim away from threats; they are not likely to swim away from a dredge and run a high risk of being entrained during construction, operation and closing of the CAD site. The Trustees distinguished Newark Bay in this regard from the species and locations involved in Superfund CAD cells at Puget Sound and New Bedford Harbor. The Trustees also concluded that other species that use the Bay (such as juvenile *Alosines,* bay anchovy and silverside) are prey species for federally managed species such as bluefish, summer flounder and windowpane. Therefore, adverse impacts on the prey species would result in reduction in prey and would be considered an adverse impact to Essential Fish Habitat. In addition, the Trustees observed that several species in Newark Bay have special status, including Atlantic sturgeon, which is federally listed as an endangered species.

The State of New Jersey has expressed similar concerns, including in a letter dated March 12, 2014, from NJDEP Commissioner Bob Martin to EPA Administrator Gina McCarthy. The Commissioner noted that use of a CAD cell for disposal of the required volume and concentration of dioxin-contaminated dredged material is unprecedented. He noted that dioxins are highly persistent, bio-accumulative and toxic chemicals that are highly resistant to degradation from biotic or abiotic processes. Consequently, NJDEP is not willing to support disposal of dioxin-contaminated sediment in Newark Bay.

In a November 30, 2012, letter, USACE stated that CAD cells can be constructed and operated with only localized short-term impacts and with the least impacts to the surrounding communities. CAD cells have been implemented all over the country, including the construction, use and recent capping of the Newark Bay Confined Disposal Facility. They noted that conditions in Newark Bay are favorable based on natural presence of a thick impermeable red-clay shelf over bedrock in a Bay with a well-established, already impacted, depositional environment (i.e., very low potential for erosion due to storm events) ensuring the secured and consolidated disposal of contaminated sediment in the long-term.

Operation of the CAD site would involve discharging dredged materials into waters of the United States for 14 years under Alternative 2, 6 years under Alternative 3 and 2.5 years under Alternative 4. The area of the open waters subject to temporary impacts from construction and operation of the CAD site would be approximately 171 acres for Alternative 2, 80 acres for Alternative 3 and 19 acres for Alternative 4. In addition to restoring the bay bottom at the completion of the project, compensatory mitigation for the CAD site would be required; that is, provision of a separate mitigation site to offset the temporal ecological losses to habitat and their functional value while the habitat is being restored. For FFS cost estimation purposes, local mitigation banks have been tentatively identified to provide the mitigation necessary to offset the temporal losses associated with the Alternatives 3 and 4 CAD site. Existing mitigation banks could only provide about 55 percent of the total mitigation acreage necessary to offset the temporal losses associated with the Alternative 2 CAD site. Additional acres could be provided through restoration of sites identified in USACE's Hudson-Raritan Estuary Comprehensive Restoration Plan and Lower Passaic River Ecosystem Restoration Plan. The cost of mitigation is included in the cost of the alternatives that include DMM Scenario A. Furthermore, in addition to habitat loss, there is the potential for fish and semi-aquatic birds moving into the open CAD cells during their 2.5- to 14-year operation and being exposed to highly concentrated contamination by direct contact or ingestion of prey.

DMM Scenarios B and C would have much less impact on the aquatic environment than DMM Scenario A, because they would not involve the discharge of contaminated sediments through the water column and into CAD cells. While DMM Scenarios B and C have greater on-land impacts (discussed above) due to the need for an upland processing facility, those impacts can be mitigated through proven technologies such as air pollution control technology and buffer zones around construction sites.

10.5.4. Short-Term Effectiveness: Time Until Remedial Response Objectives are Achieved

See Figures 19 through 22 in Appendix I for modeling results for Alternatives 1 through 4. Under Alternative 1 (No Action), lower 8.3-mile surface sediment concentrations would still be approximately 20 to 300 times higher than any of the remediation goals by the early 2060s (end of the model simulation period). Under Alternative 4 (Focused Capping with Dredging for Flooding), surface sediment concentrations would be approximately 6 to 150 times higher than any of the remediation goals by the early 2060s. For dioxin and PCBs, shortly after construction completion for Alternative 4, lower 8.3-mile surface sediment concentrations are predicted to be reduced below the first interim remediation milestone corresponding to tissue concentrations that would allow adult anglers to eat 12 eight-ounce fish or crab meals per year at a 10^{-4} cancer risk level, although lifting or relaxing prohibitions on fish and crab consumption would not be recommended because of still-elevated noncancer hazard.

For Alternatives 2 (Deep Dredging with Backfill) and 3 (Capping with Dredging for Flooding and Navigation), lower 8.3-mile surface sediment concentrations would reach levels approximately at remediation goals for dioxin and approximately four to 100 times higher than the remediation goals for PCBs, mercury and Total DDx by the early 2060s. For dioxin and PCBs, shortly after construction completion, lower 8.3-mile surface sediment concentrations are predicted to reach the interim remediation milestones that correspond to interim protective fish and crab tissue concentrations, potentially allowing NJDEP to consider lifting or relaxing the prohibitions on fish and crab consumption. Alternative 3 would achieve significant reductions in surface sediment concentrations sooner than Alternative 2 because of the shorter construction period (6 versus 14 years).

As discussed in Section 10.1, EPA's model underestimates the effectiveness of the bank-to-bank remedies because it does not account for any reduction in incoming COCs over time as the Lower Passaic River above RM 8.3 and Newark Bay are remediated under CERCLA and COCs from above Dundee Dam are addressed under Clean Water Act programs. Such actions, taken while the remedy for the lower 8.3 miles is being designed and implemented, will reduce the incoming COCs and minimize the degree of recontamination, allowing the bank-to-bank remedies (Alternatives 2 and 3) to achieve protectiveness. In contrast, while EPA's model also underestimates the effectiveness of Alternative 4 in the same way, the effect of recontamination on the protectiveness of Alternative 4 includes and is greatly exacerbated by the resuspension of contaminated sediments from the unremediated two-thirds of the lower 8.3-mile riverbed and deposition on adjacent capped areas. While EPA actions under the Superfund and Clean Water Act programs discussed above may reduce incoming COCs in the future, the resuspension of highly contaminated sediments from the unremediated two-thirds of the lower 8.3 miles will continue unabated.

10.6. Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

There are no implementability issues for Alternative 1 (No Action), which does not involve any active remediation.

For Alternatives 2 (Deep Dredging with Backfill) and 3 (Capping with Dredging for Flooding and Navigation), every step of the in-river construction (debris removal, dredging, backfilling, engineered capping and dredged material transport) would be technically implementable, although careful planning would be needed to overcome the substantial challenges involved in the handling of such large volumes of dredged materials. Equipment and technical expertise for dredging and backfill/cap placement are available through several commercial firms. While a large amount of backfill and cap material would be needed, adequate resources have been preliminarily identified at several local borrow sources.

The lower 8.3-mile river bed is crossed by utilities of various sizes and depths, in a number of locations. The much deeper dredging for Alternative 2 would affect more utilities than the shallower dredging for Alternatives 3 or 4. The remedy design will include procedures to more precisely locate utilities in the lower 8.3 miles and determine appropriate dredging off-sets, if necessary.

The lower 8.3 miles of the Lower Passaic River is crossed by 13 bridges of various heights. Some of the bridges can only be opened with extreme difficulty to allow the passage of river vessels, because they are heavily used for commuter rail (e.g., Dock Street Bridge) or automobile traffic, or because of their age and infrastructure condition. All of the active alternatives would be affected by the need to open the bridges occasionally to allow construction equipment and dredged materials through. During dredging, low profile barges exist that can pass beneath all but two of the bridges and other engineering options, such as bypass pumping, are available to transport dredged materials under the remaining two bridges, so that bridge openings are expected to be infrequent events that can be timed to minimize transportation disruptions. This issue is not expected to pose an undue hardship to bridge operators or users. The FFS incorporates the assumption that the necessary coordination, which may include assisting bridge authorities with engineering evaluations and maintenance of the bridges, would occur during the remedial design phase of the project.

In-river construction of Alternative 4 (Focused Capping with Dredging for Flooding) could be seen as more easily implementable than Alternatives 2 and 3, because smaller volumes of dredged materials would need to be handled and less capping material would be involved. However, under Alternative 4, the process of reliably identifying discrete areas that release the most contaminants into the water column would involve a great degree of uncertainty given the complex estuarine environment of the lower 8.3 miles. The river bottom changes constantly as

the tides move back and forth twice a day and unpredictably as storm events scour different areas depending on intensity, location and direction of travel.

For the in-river work of Alternatives 2, 3 and 4, no insurmountable administrative issues are anticipated in getting the necessary regulatory approvals for sediment removal or engineered cap and backfill placement. Since a large number of the activities are expected to occur on site (as defined under CERCLA §121(e)(1) and 40 CFR 300.5), federal, state and local permits would not be required. However, as discussed in Section 13.2, all substantive requirements will be met, unless there is a documented basis for a waiver. Permits are expected to be obtained from the appropriate local, state and federal agencies for actions that occur off site.

For Alternative 3, since some of the capped areas would be shallower than the federally authorized channel depths, it would be necessary to pursue both modification of the authorized depth (from RM 0.6 to RM 1.7) and deauthorization (from RM 1.7 to RM 8.3) of the federal navigation channel through Congressional action. USACE has advised that it will support those modification and deauthorization recommendations to Congress. For Alternative 4, since some of the capped areas would be shallower than the federally authorized channel depths (above approximately RM 2.7), it would be necessary to pursue deauthorization of the federal navigation channel from RM 2.7 to RM 8.3 through Congressional action. Since USACE has advised that it will support a recommendation for Congressional action to deauthorize the federal navigation channel from RM 1.7 to RM 8.3, USACE would likely also support the recommendation for Congressional action required for Alternative 4. However, as discussed above, the process of reliably identifying discrete areas that release the most contaminants into the water column involves a high degree of uncertainty given the complex estuarine environment of the lower 8.3 miles. If, during design, such discrete areas are identified in the navigation channel below RM 1.7, Alternative 4 may face an administrative implementability hurdle with respect to obtaining deauthorization or modification of the navigation channel in the lower 1.7 miles of the river. Given the current and reasonably anticipated future use of the navigation channel, such Congressional action might not be obtained.

The technical and administrative implementability of the DMM Scenarios vary. Every step involved in DMM Scenarios A (dredged material placement in CAD cells) and B (dewatering, dredged material transport and off-site disposal) is technically implementable with proper planning. The technologies have been successfully implemented at other Superfund sites. For the processing site that is eventually selected, based on EPA's analysis during the FFS and in response to comments, EPA expects that dewatering, water treatment and transfer facilities with good rail access and suitable wharf facilities can be developed. The large volume of sediments to be handled would need significant logistical coordination. For DMM Scenario B, several incinerators and landfills have been identified as potentially having capacity to receive lower 8.3-mile dredged material by rail.

The decontamination technologies involved in DMM Scenario C (thermal treatment and sediment washing) have not been constructed and operated in the United States on a scale

approaching the capacity needed for this project, so their technical ability to handle large volumes of highly contaminated sediments is more uncertain.

- At least four thermal treatment technologies were identified as potentially able to treat lower 8.3-mile dredged sediments. Pilot demonstrations were conducted by USACE for three of these technologies with Passaic River-Newark Bay sediments and for one technology with Lower Fox River (Wisconsin) sediments. All achieved over 99 percent removal efficiencies for a variety of COCs, including dioxins, PCBs, PAHs and metals, although the demonstrations involved relatively small volumes and short durations.

- At least four vendors have developed sediment washing technologies. In 2005-2006, one vendor conducted a pilot demonstration with Passaic River-Newark Bay sediments that involved sufficiently high processing rates for a limited period of time to be considered equivalent to commercial scale operation. The technology achieved variable removal efficiencies (ranging from less than 10 percent to 80 percent depending on the contaminant) for dioxins and furans, PCBs, PAHs and metals. While data from the demonstration did not conclusively establish that the system would be effective in treating all contaminants to New Jersey standards so as to allow the end product to be used beneficially without restrictions, it is possible that sediment washing, combined with solidification and stabilization technology, would enable the end product to be used as RCRA Subtitle D landfill cover. However, most recently, in mid-2012, bench-scale studies by two sediment washing technology vendors showed that their technologies were unable to reduce Lower Passaic River sediment contamination to levels low enough for beneficial use.

DMM Scenario A (CAD) is a technically viable, cost-effective solution that has been constructed and maintained in a protective manner in other locations, including Newark Bay, and Superfund sites such as New Bedford Harbor and Puget Sound Naval Shipyard. From 1997 to 2012, a CAD cell with a capacity of 1.5 million cy was operated in Newark Bay by the Port Authority of New York and New Jersey and USACE for the disposal of navigational dredged material from the Newark Bay watershed (not for disposal of sediment dredged for environmental remediation).

However, in this case, DMM Scenario A (CAD) faces unique and significant administrative and legal impediments, because the State of New Jersey has asserted ownership of the bay bottom and strongly opposes construction of a CAD site in Newark Bay, citing the high concentrations of dioxin in Lower Passaic River sediments and unprecedented volume of contaminated sediment as a primary reason it should not be disposed of in the aquatic environment. The State's position is articulated in letters dated November 28, 2012, from Governor Chris Christie to former EPA Administrator Lisa Jackson and March 12, 2014, from NJDEP Commissioner Martin to EPA Administrator Gina McCarthy. While EPA has authority to acquire property interests when needed to conduct a remedial action under Section 104(j)(1) of CERCLA, including by condemnation if necessary, Section 104(j)(2) requires prior State assurance that the State will accept the property interest when the remedial action is complete. In the March 12,

2014 letter, NJDEP stated that it will not provide the assurance required by Section 104(j)(2). Therefore, the State's opposition is likely to make DMM Scenario A administratively infeasible. Given the State's position, DMM Scenario A (CAD) is unlikely to satisfy the NCP balancing criterion of implementability and the modifying criterion of state acceptance, discussed below.

For DMM Scenario B (Off Site Disposal), administrative feasibility is less of a concern, although siting a 29- to 38-acre (depending on the alternative) upland processing facility may be challenging in the dense urban areas around the Lower Passaic River and Newark Bay. For DMM Scenario C (Local Decontamination and Beneficial Use), administrative feasibility is less of a concern than for DMM Scenario A but more of a concern than for DMM Scenario B, because Scenario C involves more upland area for dredged material processing (32 to 38 acres depending on the alternative). It also involves the construction of a thermal treatment plant, which may be subject to more stringent limitations on air emissions. In Governor Christie's November 28, 2012, letter, the State of New Jersey also expressed opposition to siting a thermal treatment facility near densely populated urban areas that are already burdened with environmental impacts, particularly from air pollutants. However, the letter acknowledged that decontamination technologies such as those described in DMM Scenario C should be considered in conjunction with off-site disposal.

10.7. Cost

Includes estimated capital and long-term operation and maintenance (O&M) present value costs.

Cost estimates are summarized in Table 32 in Appendix II. A discount rate of 7 percent was used in the present value calculations, consistent with EPA guidance.

The primary cost drivers for each remedy are the quantity of sediments to be dredged and the method of disposal. Thus, the Alternative 2 capital cost under each DMM scenario is greater than the Alternative 3 capital cost under the corresponding DMM scenario, which in turn is greater than the Alternative 4 capital cost under the corresponding DMM scenario, because Alternative 2 involves dredging and managing the largest volume of contaminated sediments, while Alternative 4 involves dredging and managing the least. All Alternative 3 and 4 operation and maintenance (O&M) costs are greater than Alternative 2 O&M costs, because Alternatives 3 and 4 would involve long-term monitoring and maintenance of an engineered cap in the lower 8.3 miles, while Alternative 2 does not involve any maintenance of the backfill (because contaminated inventory is not left behind). Annual average O&M costs for Alternative 3 and 4 over the 30 year post-construction period are comparable, at estimated present values of approximately $1.4 to $1.6 million for both Alternatives 3 and 4.

Costs for DMM Scenario B were developed with the assumption that in addition to dredged material characterized as hazardous, dredged materials that do not require treatment prior to land disposal will be placed in a RCRA Subtitle C (hazardous waste) landfill outside of New Jersey (because there are no RCRA Subtitle C landfills operating in New Jersey). EPA believes that

use of RCRA Subtitle C landfills for disposal is likely since the private parties that performed the Phase 1 Tierra Removal and the RM 10.9 Removal disposed of dredged material in RCRA Subtitle C facilities. Further, the State of New Jersey has no permitted Subtitle D landfills that are authorized to accept dredged material as solid waste for disposal. Dredged materials from coastal or tidal waters otherwise regulated under New Jersey law are specifically excluded from the definition of solid waste under New Jersey regulations.

Costs associated with local decontamination technologies (DMM Scenario C) are somewhat uncertain, since these technologies have not been built and operated in the United States on a scale approaching the capacity needed for this project. In particular, sediment washing may be less effective when the matrix contains multiple contaminants and consists of a large proportion of finer particles like silts and clays. Multiple treatment passes might be needed, which would increase cost.

Modifying Criteria *- The final criteria 8 and 9, are known as "modifying criteria." Community and support agency acceptance are factors that are assessed by reviewing comments received during the public comment period, including new information made available after publication of the proposed plan that significantly changes basic features of the remedy with respect to scope, performance, or cost.*

10.8. State Acceptance

Indicates whether based on its review of the RI/FFS reports and the Proposed Plan, the state supports, opposes, and/or has identified any reservations with the selected response measure.

The State of New Jersey concurs with the selected remedy. A letter of concurrence is attached as Appendix IV.

10.9. Community Acceptance

Summarizes the public's general response to the response measures described in the Proposed Plan and the RI/FFS reports. This assessment includes determining which of the response measures the community supports, opposes, and/or has reservations about.

Community acceptance of the selected remedy for the sediments of the lower 8.3 miles of the Lower Passaic River was evaluated based upon the comments received during the public comment period. There was overwhelming support for a remediation of the Lower Passaic River. Opinions on how that remediation should take place were more diverse. Several paper petitions sponsored by environmental, labor, university and local community groups generated over two thousand signatures in favor of the preferred alternative in the Proposed Plan (Capping with Dredging for Flooding and Navigation, with Off-Site Disposal). EPA also received almost two hundred form e-mails and pre-printed post cards supporting a concept suggested by the CPG in

its comments, which the CPG describes as a "Sustainable Remedy,"[29] an option not evaluated in the Proposed Plan. An additional 30-40 post cards expressed concern over the construction impacts of a bank-to-bank remedy.

Some elected officials on the federal, state and local levels expressed support for the preferred alternative and others expressed opposition to the preferred alternative. The CAG, which is composed of approximately 20 members representing local citizens and businesses, environmental and recreational groups, municipalities and educators, supported the preferred alternative, with two minority opinions supporting Alternative 2 (Deep Dredging with Backfill) with off-site disposal or CAD. Some environmental groups supported the preferred alternative, while others supported Alternative 2 with off-site disposal or local decontamination. Groups representing businesses and economic development generally expressed support for the CPG's "Sustainable Remedy." Many local boating and rowing clubs expressed concern over the impacts on their ability to use the river during the construction of a bank-to-bank remedy. Companies that have received notices of potential responsibility that submitted comments all opposed a bank-to-bank remedy, and most supported the CPG's "Sustainable Remedy." Each of the active alternatives (i.e., alternatives other than "No Action") received support from various individual stakeholders, and many local residents expressed concern over the construction impacts of any remediation, even if they wrote to support some form of remediation.

While requesting comments on all aspects of the Proposed Plan, EPA provided focused public outreach on two aspects of the preferred alternative: the choice of off-site disposal versus a CAD site in Newark Bay and the dredging depths for the federally authorized navigation channel from RM 0 to RM 2.2. Of the commenters who specifically commented on off-site disposal versus CAD, more expressed support for than opposition to off-site disposal and conversely, more expressed opposition to than support for CAD, for reasons that are described in the Responsiveness Summary. Note that many of those who expressed opposition to a CAD site in Newark Bay identified themselves as residents of the Ironbound in Newark, a community with a number of potential environmental justice concerns.

Of those who specifically commented on the navigation channel, some supported dredging the navigation channel to the maximum extent while others expressed the opinion that deeper dredging in the navigation channel should not have been included in any of the alternatives. Some commenters stated that the analysis in the 2010 USACE report should be updated to include the latest information on navigation in the Lower Passaic River. Entities who identified themselves as operating within the lower 0.6 miles of the Passaic River supported dredging and

[29] During the development of the RI/FFS and Proposed Plan, and in their comments on the Proposed Plan, the CPG did not submit enough information for EPA to evaluate the conceptual remedy that the CPG calls a "Sustainable Remedy." EPA did develop and include a less than bank-to-bank, or focused, remedial alternative (Alternative 4) in the RI/FFS and Proposed Plan. Alternative 4 includes dredging and capping discrete areas of the lower 8.3 miles that release the most contaminants into the water column. Those areas cumulatively total approximately 220 acres of the surface of the lower 8.3 miles. The CPG's "Sustainable Remedy" would address discrete areas of highest surface sediment concentrations in the 17-mile stretch of the Lower Passaic River that would cumulatively total approximately 150 acres of the surface of the 17 miles.

maintaining the navigation channel as critical to their businesses or operations. Commenters' reasons for supporting or opposing deeper dredging in the navigation channel are described in the Responsiveness Summary.

Appendix V, the Responsiveness Summary, addresses the comments received at the public meetings and written comments received during the public comment period.

11. PRINCIPAL THREAT WASTE

The NCP establishes an expectation that EPA will use treatment to address the principal threats posed by a site wherever practicable (NCP §300.430(a)(1)(iii)(A)). Principal threat wastes are source materials that include or contain hazardous substances, pollutants or contaminants that act as a reservoir of contaminants that can migrate to groundwater, surface water or air, or act as a source for direct exposure. Contaminated groundwater generally is not considered to be a source material; however, non-aqueous phase liquids in groundwater may be viewed as source material. Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained, or would present a significant risk to human health or the environment should exposure occur. Low-level threat wastes are those wastes that generally can be reliably contained and present only a low risk in the event of exposure. The identification of principal and low level threats is made on a site-specific basis to help streamline and focus waste management options by categorizing the suitability of the waste for treatment or containment.

The dioxin, PCB and other COC concentrations in sediments throughout the lower 8.3 miles of the Lower Passaic River are present at levels contributing to 10^{-3} risks for humans consuming fish and crab caught in the lower 8.3 miles, a risk level that can be used as a basis for identifying principal threat waste. Although the engineering and sediment transport modeling work done as part of the FFS has determined that the deeper sediment, despite its toxicity, can be reliably contained, EPA nevertheless considers the most highly contaminated sediments as principal threat wastes at the site. As such, EPA has considered treatment as a component of dredged material management. EPA does not believe that additional treatment of all the sediment in the lower 8.3 miles is practicable or cost effective, given the high volume of sediment, the number of COCs that would need to be addressed, and the lack of applicable treatment technologies.

12. SELECTED REMEDY

Based upon an evaluation of the results of Site investigations, input from the NRRB and the CSTAG, the detailed analysis of the various remedial alternatives, and public comments, EPA has selected Alternative 3 (Capping with Dredging for Flooding and Navigation) with DMM Scenario B (Off-Site Disposal) as the remedy for OU2, the sediments of the lower 8.3 miles of the Lower Passaic River.

The major components of the selected remedy include the following:

- An engineered cap will be constructed over the river bottom of the lower 8.3 miles, except in areas where backfill may be placed because all contaminated fine-grained sediments have been removed. The engineered cap will generally consist of two feet of sand and may be armored where necessary to prevent erosion of the sand.

- Before the engineered cap is installed, the river will be dredged bank to bank (approximately 3.5 million cubic yards) so that the cap can be placed without increasing the potential for flooding. Depth of dredging is estimated to be 2.5 feet, except in the 1.7 miles of the federally authorized navigation channel closest to Newark Bay.

- The remedy will include sufficient dredging and capping to allow for the continued commercial use of a federally authorized navigation channel in the 1.7 miles of the river closest to Newark Bay and to accommodate reasonably anticipated future recreational use above RM 1.7.

- Dredged materials will be barged or pumped to a sediment processing facility in the vicinity of the Lower Passaic River/Newark Bay shoreline for dewatering. Dewatered materials will be transported to permitted treatment facilities[30] and landfills in the United States or Canada for disposal.

- Mudflats dredged during implementation of the remedy will be covered with an engineered cap consisting of one foot of sand and one foot of mudflat reconstruction (habitat) substrate.

- Institutional controls will be implemented to protect the engineered cap. In addition, New Jersey's existing prohibitions on fish and crab consumption will remain in place and will be enhanced with additional community outreach to encourage greater awareness of the prohibitions until the concentrations of COCs in fish and crab tissue reach protective concentrations corresponding to remediation goals. EPA will share the data and consult with NJDEP about whether the prohibitions on fish and crab consumption advisories can be lifted or adjusted to allow for increased consumption as contaminant levels decline.

- Long-term monitoring and maintenance of the engineered cap will be required to ensure its stability and integrity. Long-term monitoring of fish, crab and sediment will also be performed to determine when interim remediation milestones, remediation goals and remedial action objectives are reached. Other monitoring, such as water column sampling, will also be performed.

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[30] At this time, incineration is the only technology known to be able to treat sediments to the applicable RCRA standards if those sediments are characterized as hazardous under RCRA and contain dioxin as an underlying hazardous constituent at concentrations requiring treatment.

This is the first of three remedies to be selected for the Lower Passaic/Newark Bay waterway: separate RI/FSs are being conducted for the full 17-mile LPRSA and for the Newark Bay Study Area, and EPA expects the three remedies to be integrated into a comprehensive response action.

Further details on the selected remedy for the sediments of the lower 8.3 miles of the Lower Passaic River include:

12.1. Dredging to Allow For Engineered Capping

Prior to installing an engineered cap bank to bank in the lower 8.3 miles of the Lower Passaic River, dredging to approximately 2.5 feet below the existing sediment surface will be performed to prevent the engineered cap from causing additional flooding. That is, when the remedy is complete, the elevation of the bottom of the river will approximate its current depth. While the FFS evaluated dredging using a mechanical dredge fitted with an environmental clamshell bucket, hydraulic dredging may also be used for some or all of the work if this is determined to be appropriate during design. If, during design, other dredging methods are identified, they will be evaluated as well.

Except as discussed in Section 12.2, the depth of dredging will be governed by the thickness of the cap. An engineered cap will be installed to provide chemical isolation, and protect against disturbance from natural processes (e.g., bioturbation) and weather events. Areas of the river that are subject to higher erosion potential may need armoring to reduce loss of cap material. The cap thickness is expected to be, on average, 2 feet, although it may be determined during remedy design that the cap thickness can vary in segments of the lower 8.3 miles as long as protectiveness is maintained.

Dredging and capping will proceed in sequence to minimize the period in which deeper contaminated sediments are exposed. The final amount to be dredged, thickness of the engineered cap and material to be used for the cap will be determined during remedy design.

Dredging/capping are assumed to occur for 32 weeks per year to account for equipment maintenance, weather-related delays and the fish window. During the remedy design, a fish migration study will better define the fish window.

The selected remedy also includes the reconstruction of dredged mudflats to their original grade, with an engineered cap that would consist of 1 foot of sand and 1 foot of mudflat reconstruction (habitat) substrate.

12.2. Navigation Channel Capping/Dredging

The selected remedy includes dredging the 300-foot wide federal navigation channel from RM 0 to RM 1.7 to accommodate continued and reasonably anticipated future use as shown in Table 33 in Appendix II.

12.3. Dredging for Recreational Use

Above RM 1.7, dredging will provide for at least 10 feet below MLW to accommodate reasonably anticipated future recreational uses, as shown in Table 33 in Appendix II.

12.4. Dredged Materials Management

This action will result in the dredging of approximately 3.5 million cy of contaminated sediments, which will be disposed of in the following way:

- Dredged materials will be barged or pumped to an upland sediment processing facility in the vicinity of the Lower Passaic River/Newark Bay shorelines for debris screening, sand separation and active dewatering using filter presses. The upland sediment processing facility will include a water treatment plant to treat contaminated water generated from sediment dewatering to meet NJDEP water quality standards before discharging it to the Lower Passaic River or Newark Bay.

- Non-hazardous coarse-grained materials (sand) separated during processing will be disposed of at a local landfill, or be beneficially used in compliance with applicable regulations.

- Dewatered dredged materials will be transported to permitted landfills in the United States or Canada for disposal.

- Some lower 8.3-mile sediments have the potential to be characterized as hazardous under RCRA standards. At this time, incineration is the only technology known to be able to treat sediments to the applicable RCRA standards if those sediments are characterized as hazardous under RCRA and contain dioxin as an underlying hazardous constituent at concentrations requiring treatment. The ash generated by incineration will be disposed of in a RCRA Subtitle C landfill.

- Dredged materials characterized as non-hazardous may be disposed of directly in a landfill without treatment. For cost-estimation purposes, placement in a RCRA Subtitle C (hazardous waste) landfill outside of New Jersey was assumed, since that was the disposal method selected by private parties performing both Phase 1 of the Tierra Removal and the RM 10.9 Removal.

12.5. Performance Standards

Performance standards related to remedy implementation will be developed during the remedy design in consultation with the State of New Jersey and federal Natural Resource Trustees, based on environmental and scientific criteria. These performance standards will be incorporated in design documents. The standards will promote accountability and ensure that the remedy meets the action-specific ARARs.

12.6. Habitat Restoration

Measures to reconstruct habitat impacted by the dredging and capping will be implemented, including habitat assessment and surveys during remedy design. The design will address placement of habitat recovery material and aquatic vegetation and is discussed further in Section 9.2.3.

12.7. Monitoring, Engineered Cap Maintenance and Institutional Controls

During construction (i.e., dredging, capping and upland sediment processing facility operations), water, air and biota monitoring will be conducted to evaluate whether the project is being managed efficiently to mitigate releases of contaminants to the environment. In instances where water or air quality standards are exceeded, the construction activity that caused the exceedance will be evaluated and additional mitigation measures will be implemented. After construction, monitoring of fish, crab and sediment will be conducted to determine when interim remediation milestones and remedial action objectives are reached.

During and after construction, New Jersey's prohibitions on fish and crab consumption, with enhanced community outreach to improve awareness, will remain in place until RAOs are met. EPA and NJDEP will share data and evaluate whether and when New Jersey may lift prohibitions on fish and/or crab consumption, replacing them with advisories that can be adjusted to allow for increased consumption as contaminant levels decline.

After construction, monitoring and maintenance of the engineered cap will be required both on a regular basis and after significant storm events. Institutional controls prohibiting disturbance of the engineered cap will be necessary to maintain cap integrity.

Frequency of monitoring during and after construction activities will be identified in monitoring plans developed during remedial design.

12.8. Adaptive Management

As discussed in EPA's "Contaminated Sediment Remediation Guidance for Hazardous Waste Sites" (December 2005) Section 2.7, adaptive management is encouraged in addressing large and complex contaminated sediment sites. Further, in its 2007 report on sediment dredging at Superfund sites, the National Research Council (NRC) noted the "difficulty in predicting dredging effectiveness and the limited number of available alternative technologies." The NRC also noted that environmental responses to remediation are complex and difficult to predict. The NRC recommended an "adaptive management approach" which it defined as "[t]he use of a structured process of selecting a management action, monitoring the effects of the action, and applying those lessons to optimize a management action…." The NRC noted that adaptive management is "context-specific" and involves an active learning process. The NRC also noted that adaptive management is not a means to permit or sanction a less rigorous cleanup or avoid

public input, and stressed the importance of working in concert with site stakeholders so they can contribute to adapting the remedy if necessary. The NRC also stated that it is important not only to evaluate new information as it becomes available, but also to document deviations from the plan, if any.

Given the complexity and uncertainty involved with remediating sediment sites, especially at such a large scale, as recommended by the NRC, EPA expects to employ an adaptive management approach during the remedial design and implementation of the remedy. This will allow for appropriate adjustments to ensure efficient and effective remediation. Information critical to the successful implementation of the remedy will be evaluated; for example, models may be reviewed and updated and new projections made which may provide the opportunity for modifications to the remedial action to be considered, if appropriate. As discussed in Section 9.1.3, during remedy design, EPA will evaluate enhanced capping technologies, such as the use of additives (e.g., activated carbon or organoclay) to create a reactive cap or thin-layer capping technologies where conditions are conducive to such approaches. As appropriate, remedy modifications will be made and documented in accordance with the CERCLA process, through a memorandum to the Site file, an Explanation of Significant Differences or an Amendment to the ROD.

Furthermore, EPA will evaluate remedy implementation and modify activities as appropriate to attain remediation goals and remedial action objectives more effectively. This ensures that uncertainties are promptly and effectively addressed, informs specific design decisions, and addresses concerns about how this action will be integrated with the ongoing 17-mile LPRSA RI/FS being carried out by the CPG under EPA oversight.

12.9. Staging Remedy Implementation

The selected remedy will be implemented over an estimated 6 years of active dredging and capping. Accordingly, there will be opportunities to use experience gained, and monitoring data, to influence the implementation and performance of later stages of the remedy. EPA anticipates that, during implementation, some aspects of the remedy can be optimized, improving efficiency and potentially reducing costs. For most of the lower 8.3 miles (outside channel-dredging areas discussed in Section 12.2), the need for dredging prior to capping is derived from information about system stresses that may result from changing the river bottom bathymetry and sediment grain size (affecting the erosional stresses on the cap and the amount of flood-storage capacity within the river). As the cost of the remedy is substantially driven by the cost of dredging and dredged material management, earlier stages of dredging followed by capping can inform later stages, potentially reducing the cost by allowing EPA to evaluate opportunities to potentially reduce the amount of dredging while still allowing for installation of a protective and stable engineered cap.

In addition, EPA expects to select remedies for the Lower Passaic River above RM 8.3 and Newark Bay under the Superfund program and, working with New Jersey, to address COCs from above Dundee Dam under Clean Water Act programs. Such actions, taken while the selected

remedy is being designed and implemented, will reduce the incoming COCs and minimize the degree of recontamination, allowing the selected remedy to achieve protectiveness.

12.10. Future Changes to the Navigation Channel

Capping the navigation channel at a depth other than the currently authorized depth will depend on coordination with USACE and the State of New Jersey, and successful completion of the process to obtain Congressional action to modify the depths and deauthorize portions of the navigation channel. Accordingly, the actual channel dredging depths may be refined further prior to implementation of the remedy.

12.11. Upland Sediment Processing Facilities and Local Decontamination and Beneficial Reuse

There may be adaptive management opportunities in the construction of an upland sediment processing facility, including the construction of smaller sediment dewatering and management units that can be expanded as necessary. In addition, while DMM Scenario C has not been selected, primarily for implementability reasons (e.g., the challenges of constructing and operating a sediment decontamination and beneficial reuse facility on a scale approaching the capacity needed for the selected remedy), EPA plans to follow an adaptive management approach to dredged materials management that seeks opportunities for on-site treatment that allows for beneficial reuse, as discussed in more detail in Section 12.13.

12.12. Green Remediation

The environmental benefits of the selected remedy may be enhanced by consideration of technologies and practices during the design of the remedy that are sustainable in accordance with EPA Region 2's Clean and Green policy. This will include consideration of green remediation technologies and practices.

12.13. Rationale For Selection of Alternative 3, DMM Scenario B

The selection of a remedy is accomplished through the evaluation of the nine criteria as specified in the NCP. The preference for the selected alternative and DMM scenario is based upon these principal factors:

Alternative 3 with DMM Scenario B meets the threshold criteria of Overall Protection of Human Health and the Environment and Compliance with ARARs. This alternative, which relies on an engineered cap bank-to-bank over the entire lower 8.3 miles of the Lower Passaic River to isolate the contaminated sediment in the lower 8.3 miles, achieves substantial risk reduction and controls a major source of contamination to the rest of the Lower Passaic River and Newark Bay. EPA will share data and consult with NJDEP about whether New Jersey's prohibitions on fish and crab consumption, incorporated to ensure protection of human health, can be lifted or adjusted to allow for increased consumption as contaminant levels decline. The selected remedy

will meet all of the RAOs for the lower 8.3 miles and will accommodate the reasonably anticipated future use in the federally authorized navigation channel, as well as future recreational use. Following are the key factors that led EPA to select this alternative-DMM scenario combination over the others:

- Alternative 3 achieves substantial risk reduction and controls a major source of contamination to the rest of the Lower Passaic River and Newark Bay by sequestering all of the contaminated sediments remaining in the lower 8.3 miles of the Lower Passaic River at the completion of the remedy under a bank-to-bank engineered cap. While engineered caps must be monitored and maintained in perpetuity, they have been demonstrated to be effective for well over 30 years at multiple Superfund sites around the country.

- Alternative 3 reduces the contaminant volume in the lower 8.3 miles of the Lower Passaic River by removing 3.5 million cy of contaminated sediments. Alternative 3 reduces mobility in the lower 8.3 miles by sequestering the remaining 6.2 million cy of contaminated sediments under an engineered cap that will be maintained in perpetuity. Overall toxicity and volume are reduced by incinerating the 5 percent of dredged materials estimated to be characterized as hazardous under RCRA (with dioxin concentrations elevated such that incineration is needed), while overall mobility is effectively eliminated by disposing of the remaining volume (and the ash from incineration) into landfills.

- While both Alternatives 2 and 3 meet the threshold criterion of protectiveness, Alternative 3 will do so in less than half the construction time of Alternative 2 and with a smaller volume dredged than Alternative 2. This means that there will be significantly less short-term impact on the community, workers and the environment.

- DMM Scenario B has less of an on-land impact than DMM Scenario C, since off-site disposal will involve fewer acres for, and less processing at, the upland processing facility than local decontamination. DMM Scenario B has significantly less impact on the aquatic environment than DMM Scenario A, since CAD cells, unlike off-site disposal, would involve managing the placement of dredged materials on 80 acres of Newark Bay bottom over 6 years, potentially impacting species that are dependent on limited bay bottom habitat for critical life stages. In addition, CAD cells could increase the potential that fish and birds could be exposed to highly concentrated contamination in the CAD cells, and increase the potential for waterborne commerce accidents in the busy port.

- The cost estimate for the selected remedy assumes that dredged materials that do not require treatment prior to land disposal will be placed in a RCRA Subtitle C landfill. Because the private parties that performed the Phase 1 Tierra Removal and the RM 10.9 Removal disposed of dredged material in RCRA Subtitle C facilities, EPA believes it likely that the dredged material for this action will also go to Subtitle C facilities. Further, because dredged materials from coastal or tidal waters, otherwise regulated

under New Jersey law, are specifically excluded from the definition of solid waste under New Jersey regulations, the State of New Jersey has no permitted Subtitle D landfills that are authorized to accept dredged material as solid waste for disposal.

- The dredging and engineered cap components in Alternative 3 have been demonstrated to be technically and administratively feasible at other Superfund sites. Alternative 3 is more implementable than Alternative 2, because Alternative 3 involves a significantly smaller dredging volume and shallower dredging depths than Alternative 2, which means less challenging logistics for sediment handling and fewer utilities to be located and evaluated. Alternative 3 is more implementable than Alternative 4, because Alternative 3 does not rely on identifying discrete areas of the river that release high fluxes of contaminants into the water column. The river bottom changes constantly as the tides move back and forth twice a day and unpredictably as storm events scour different areas depending on intensity, location and direction of travel, making the identification of the discrete areas that would be remediated under Alternative 4 highly uncertain.

- While the final decisions regarding treatment and disposal locations will be made during remedy design and implementation, for DMM Scenario B, existing incinerators and landfills were identified that are permitted to handle lower 8.3-mile dredged materials, are proven to be reliable technologies and already have provisions for long-term monitoring and maintenance by their owners/operators. In contrast, because the State of New Jersey strongly opposes construction of a CAD site in Newark Bay, DMM Scenario A is likely to face such severe legal and administrative impediments as to make it administratively infeasible. The sediment washing technologies evaluated in DMM Scenario C failed in demonstration tests to reliably reduce Lower Passaic River sediment contamination to levels low enough to allow for beneficial re-use, and thermal treatment technology vendors have not sited or constructed commercial-scale facilities with the demonstrated ability to process the large volumes of sediment that would be dredged under Alternative 3.

- At a present value of $1.38 billion, Alternative 3-DMM Scenario B is less costly than the two most costly alternative-DMM scenario combinations, although more costly than three others (excluding Alternatives 1 and 4, which do not meet the protectiveness threshold criterion).

- The State of New Jersey has concurred with the combination of Alternative 3 and DMM Scenario B.

- On balance, the comments received on the Proposed Plan, particularly from local residents and many community organizations, supported the combination of Alternative 3 and DMM Scenario B.

DMM Scenario C would offer some advantages in terms of permanence and reduction of toxicity, mobility and volume through treatment. However, none of the decontamination

technologies tested during the FFS development period proved implementable on a commercial scale, particularly with the large volumes of sediment that would require management under the active alternative evaluated. Several sediment decontamination vendors are continuing to develop their technologies and continue to express interest in handling Lower Passaic River sediments. It is possible that one or more vendors might succeed in demonstrating that their technology could decontaminate Lower Passaic River sediments and might be able to site and construct a local decontamination technology facility. Should this happen during the remedy design phase, EPA could modify the selected remedy through a ROD amendment or Explanation of Significant Differences in such a way as to allow for local decontamination and beneficial use (DMM Scenario C) of all or a portion of the sediment.

Based on information currently available, EPA concludes that the selected remedy meets the threshold criteria and provides the best balance of tradeoffs among the alternatives with respect to the balancing and modifying criteria. The selected remedy will satisfy the statutory requirements of CERCLA §121(b) by being protective of human health and the environment; complying with ARARs; and being cost-effective. Although CERCLA §121(b) also expresses a preference for selection of remedial actions that use permanent solutions and treatment technologies to the maximum extent practicable, there are situations that may limit the use of treatment, including when treatment technologies are not technically feasible or when the extraordinary size or complexity of a site makes implementation of treatment technologies impracticable. The selected remedy would generate approximately 3.5 million cy of contaminated sediments, which is an extraordinary volume of material; and the sediment treatment technologies investigated under DMM Scenario C have not been constructed or operated in the United States on a scale approaching the capacity needed for this project, so their technical ability to handle such an extraordinary volume of highly contaminated sediments is uncertain. The selected remedy is estimated to provide treatment of approximately 130,000 cy of contaminated sediment through incineration off-site to comply with applicable RCRA standards.

12.14. Summary of the Estimated Cost of the Selected Remedy

The estimated capital, long-term O&M and total present value costs, as well as construction time, for the selected remedy are summarized below and detailed in Tables 34 and 35 in Appendix II. The cost estimates, which are based upon estimates developed for similar projects, engineering judgment and construction bids, are order-of-magnitude engineering cost estimates that are expected to be within +50 percent to -30 percent of the actual cost for implementation of the remedy.

Total Present Value Capital Cost:	$1,338,000,000
Average Annual Present Value O&M Cost:	$ 1,468,000
Total Present Value Cost:	$1,382,000,000
Construction Duration:	6 Years

12.15. Expected Outcomes of the Selected Remedy

The selected remedy, Alternative 3 combined with DMM Scenario B, addresses a major source of contamination to the Lower Passaic River and Newark Bay. Risks to humans through fish and crab consumption, risks to ecological receptors due to direct contact and ingestion of contaminated sediments and prey, and resuspension of contaminated sediment acting as an ongoing source of contamination will be mitigated through the installation of an engineered cap over the lower 8.3 miles of the Lower Passaic River, bank to bank (except in areas where backfill may be placed, because all contaminated fine-grained sediments have been removed). To prevent the engineered cap from exacerbating flooding, removal of approximately 2.5 feet of surface sediments will be necessary. This is the first stage of a multi-phased action to address human health and ecological risks posed by contaminated sediments, water and biota in the entire 17 miles of the Lower Passaic River and in Newark Bay. The installation of an engineered cap will address exposures by remediating contaminated sediments in the lower 8.3 miles, thereby improving water column concentrations and lowering fish and crab tissue concentrations. Modeling predicts that fish and crab tissue concentrations may be reduced sufficiently after remedy implementation to allow for some adjustments of the current prohibitions on fish and crab consumption to allow for some consumption. Actions taken to reduce the incoming COCs and minimize the degree of recontamination will result in further improvements in fish and crab tissue concentrations. EPA does expect that some level of fish and crab consumption prohibitions or advisories will be needed during construction of the remedy and after construction completion to maintain the protectiveness of the remedy.

The model-projected outcomes for the lower 8.3 miles of the Lower Passaic River, described above, underestimate the effectiveness of the selected remedy, because they do not account for any reduction in incoming COCs over time as the Lower Passaic River above RM 8.3 and Newark Bay are remediated under the Superfund program and COCs from above Dundee Dam are addressed under Clean Water Act programs. Such actions, taken while the selected remedy is being designed and implemented, will reduce the incoming COCs and minimize the degree of recontamination, allowing the selected remedy to achieve protectiveness. This action for the sediments of the lower 8.3 miles of the Lower Passaic River will effectively eliminate the sediments of the lower 8.3 miles as an ongoing source of contamination to the other study areas. The upper nine miles of the Lower Passaic River and Newark Bay, which cover a greater surface area than the lower 8.3 miles of the Lower Passaic River, but account for less of the contaminant loading into the system, may see risk reduction from the implementation of the lower 8.3-mile remedy alone. At the same time, because the vast majority of the contaminated sediments are present in the lower 8.3 miles, and bank-to-bank remediation is necessary to address the unacceptable risk associated with these sediments, any remedy for the 17-mile Lower Passaic River that includes the lower 8.3 miles would necessarily have to address these contaminated sediments. For these reasons, EPA expects that the selected remedy for the sediments of the lower 8.3 miles will be consistent with any remedy selected for Lower Passaic River and Newark Bay.

Except for the two miles closest to Newark Bay, the federally authorized navigation channel in the lower 8.3 miles has not been regularly maintained in recent years. Based on EPA's analysis of USACE's 2010 Lower Passaic River Commercial Navigation Analysis report and comments submitted to EPA on the Proposed Plan, EPA does not anticipate that the channel above RM 1.7 is likely to be used for commercial navigation in the foreseeable future. The lowest 1.7 miles are currently used for commercial navigation, and USACE has indicated that maintaining the channel from RM 0 to RM 1.7 is consistent with its current and reasonably anticipated future use. USACE has advised that based on current information about reasonably anticipated future use of the channel, it will support recommendations for Congressional action to: 1) deauthorize the federal navigation channel from RM 1.7 to RM 8.3; and 2) modify the authorized depths of the federal navigation channel from RM 0.6 to RM 1.7 to the depths identified in the selected remedy. Thus, the final capping depths for the federally authorized navigation channel between RM 0 and RM 1.7 that are part of the selected remedy, including those between RM 0.6 and RM 1.7 that are less than the currently authorized channel depths, are consistent with reasonably anticipated future use including commercial navigational use.

Long-term monitoring of the remedy and maintenance of the engineered cap will be conducted to ensure the integrity of the engineered cap and the protectiveness of this remedy. Any identified deficiencies in the engineered cap will be addressed in an expeditious fashion in accordance with an O&M plan, to be developed during remedial design to ensure the continued protectiveness of the selected remedy.

13. STATUTORY DETERMINATIONS

CERCLA §121(b)(1) mandates that a remedial action must be protective of human health and the environment, cost-effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. CERCLA §121(b)(1) also establishes a preference for remedial actions which employ treatment to permanently and significantly reduce the volume, toxicity or mobility of the hazardous substances, pollutants, or contaminants at a site. CERCLA §121(d) further specifies that a remedial action must attain a degree of cleanup that satisfies ARARs under federal and state laws, unless a waiver can be justified pursuant to CERCLA §121(d)(4).

13.1. Protection of Human Health and the Environment

The selected remedy's components will be protective of human health and the environment by removing or capping principal threat waste from the areas encompassed by this OU, removing and/or reducing the availability of the contaminated sediment throughout the lower 8.3 miles of the Lower Passaic River through surface dredging followed by capping, so that in time, surface sediment will approach remediation goals as closely as possible. Actions selected after the completion of the 17-mile RI/FS and Newark Bay RI/FS will reduce incoming COCs from the Lower Passaic River above RM 8.3 and Newark Bay, respectively, and Clean Water Act programs are expected to address COCs from above Dundee Dam. Such actions, taken while the selected remedy is being designed and implemented, will reduce the incoming COCs and

minimize the degree of recontamination, allowing the selected remedy to achieve protectiveness by achieving the cancer risk range of 10^{-4} to 10^{-6}, noncancer HIs equal to or less than 1 and ecological HQs equal to or less than 1.

The selected remedy for the sediments of the lower 8.3 miles of the Lower Passaic River will be protective of human health and the environment. The selected remedy, Alternative 3, will prevent exposure and ingestion risks to humans and ecological receptors associated with contaminated sediments by containing this material under an engineered cap. Because the time frame required to achieve remedial action objectives is long, further risk reduction will be attained in the short-term through enhanced outreach to increase awareness of existing fish and crab consumption prohibitions and advisories, including complementary education efforts to reduce the consumption of self-caught fish and crab while contaminant concentrations remain above remediation goals in the fish and crab tissue.

The extensive dredging, sediment processing and off-site transportation of contaminated material associated with this remedy have the potential for significant impacts on the community and workers during its implementation. Measures to minimize and mitigate the impacts associated with these activities will be addressed in community and worker health and safety plans, by the use of best management practices and by following approved health and safety procedures.

13.2. Compliance with ARARs

CERCLA §121(d) and NCP §300.430(f)(1)(ii)(B) require that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria, and limitations which are collectively referred to as "ARARs," unless such ARARs are waived under CERCLA §121(d)(4). Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or State environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site (or operable unit).

The selected remedy sequesters contaminated sediments under an engineered cap over the entire river bottom, throughout the lower 8.3 miles of the Lower Passaic River. EPA expects that during implementation, this remedy will be implemented consistent with identified action-specific and location-specific ARARs and performance standards, and once implemented, will comply with all ARARs. A complete list of the ARARs, and to-be-considered (TBCs) criteria associated with the selected remedy is presented in Table 29 in Appendix II.

Highlights of ARARs:

- Action Specific ARARs -
  - Clean Water Act, 33 U.S.C. §404(b)(1); 40 CFR Part 230
  - New Jersey Pollutant Discharge Elimination System rules, N.J.A.C. 7:14A-12
  - Resource Conservation and Recovery Act, 42 U.S.C. §6921; 40 CFR Parts 262, 264, 268
  - New Jersey Solid Waste Management Act, N.J.S.A. §13:1E-1, et seq., New Jersey Solid and Hazardous Waste Rules, N.J.A.C. 7:26 and 7:26G

- Chemical-Specific ARARs (none)

- Location-Specific ARARs
  - Section 10, Rivers and Harbors Act of 1899, 33 U.S.C. §403
  - Coastal Zone Management Act, 16 U.S.C.§1456; 15 CFR 930.30
  - New Jersey Tidelands Act, N.J.S.A. 12:3
  - New Jersey Waterfront Development Law, N.J.S.A 12:5-3
  - New Jersey Coastal Zone Management Rules N.J.A.C. 7:7
  - New Jersey Flood Hazard Control Act Rules, N.J.A.C. 7:13
  - New Jersey Freshwater Wetlands Protection Act Rules, N.J.A.C. 7:7A.

13.3. Cost Effectiveness

EPA has determined that the selected remedy is cost-effective and represents a reasonable value. In making this determination, the following definition was used: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness" (NCP §300.430(f)(1)(ii)(D)). EPA evaluated the "overall effectiveness" of those alternatives that satisfied the threshold criteria (*i.e.*, were protective of human health and the environment and ARAR-compliant). Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination (long-term effectiveness and permanence; reduction in toxicity, mobility, or volume through treatment; and short–term effectiveness). Overall effectiveness was then compared to costs to determine cost-effectiveness. The relationship of the overall effectiveness of the selected remedy was determined to be proportional to costs and hence, the selected remedy represents reasonable value.

Please refer to Tables 34 and 35 in Appendix II for a summary of costs for the selected remedy.

13.4. Use of Permanent Solutions and Alternative Treatment Technologies

EPA has determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner. Of those alternatives that are protective of human health and the environment and comply with ARARs to the extent practicable, EPA has determined that the selected remedy provides the best balance of

trade-offs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element and State and community acceptance.

The selected remedy will provide adequate long-term control of risks to human health and the environment through eliminating and/or preventing exposure to the contaminated sediment and preventing movement of contaminated sediment. The selected remedy is protective with respect to short-term risks.

13.5. Preference for Treatment as a Principal Element

Although CERCLA §121(b) also expresses a preference for selection of remedial actions that use permanent solutions and treatment technologies to the maximum extent practicable, there are situations that may limit the use of treatment, including when treatment technologies are not technically feasible or when the extraordinary size or complexity of a site makes implementation of treatment technologies impracticable. The selected remedy would generate approximately 3.5 million cy of contaminated sediments, which is clearly an extraordinary volume of materials; and the sediment treatment technologies investigated under DMM Scenario C have not been constructed or operated in the United States on a scale approaching the capacity needed for this project, so their technical ability to handle such an extraordinary volume of highly contaminated sediments is uncertain. The selected remedy is estimated to provide treatment of approximately 130,000 cy of contaminated sediment through incineration (the only technology available at this time) off site to comply with applicable RCRA standards. If, during remedial design, EPA identifies an enhanced capping technology that includes additives to create a reactive cap for use in some areas of the lower 8.3 miles, the selected remedy may provide some *in situ* treatment.

13.6. Five-Year Review Requirements

Because the selected remedy will result in hazardous substances, pollutants, or contaminants remaining in sediments above levels that allow for unlimited use and unrestricted exposure, reviews will be conducted every five years after initiation of the remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

14. DOCUMENTATION OF SIGNIFICANT CHANGES

In response to comments received on the Proposed Plan, EPA has altered some aspects of the preferred alternative (Alternative 3 with DMM Scenario B) in the Proposed Plan in formulating the selected remedy. This section briefly describes the changes, which are discussed in more detail in the Responsiveness Summary in Appendix V.

Selected Remediation Goals. EPA received comments that the human health risk assessment supporting the Proposed Plan should have been updated to reflect the 2014 Updated Default Exposure Assumptions (released after the RI/FFS was completed). In response to these comments, EPA used the updated assumptions to calculate risk and hazard estimates used to support remedy selection as set forth in this ROD:

- The updated assumptions changed the adult exposure duration from 24 years to 20 years and the total exposure duration from 30 years to 26 years. As shown in the Responsiveness Summary in Appendix V, incorporating the updated assumptions does not significantly affect the calculated cancer risks and does not alter noncancer values.
- The updated assumptions changed the adult body weight from 70 kg (154 pounds) to 80 kg (176 pounds). As shown in the Responsiveness Summary, incorporating this updated assumption does not significantly affect the calculated risks and health hazards.
- In addition to recalculating the risk and hazard estimates, EPA also used the updated assumptions to recalculate the human health PRGs, which resulted in the dioxin and PCB remediation goals, both based on human health PRGs, changing by 14 percent (from 7.1 ppt to 8.3 ppt) and 17 percent (from 44 ppb to 50 ppb), respectively.

Navigation Channel. EPA received comments on the depths and extent of dredging in the federally authorized navigation channel included in Alternative 3. In response to those comments, EPA, in consultation with USACE and NJDEP, reexamined available information pertaining to current and future land use and commercial uses of the Lower Passaic River navigation channel submitted and obtained during the public comment period:

- In 1930, Congress authorized the navigation channel depth for the portion of the Passaic River from RM 0 to RM 2.6 to be 30 feet, and has not modified this authorized navigation channel depth since that time.
- Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. § 403) is a location-specific ARAR with which the remedy for the lower 8.3 miles will comply. In addition, it is EPA policy to consider reasonably anticipated future land and waterway uses during the remedy selection process in general, and in the development of remedial alternatives in particular.
- In developing a preferred alternative that included capping that would not permanently obstruct the navigable capacity of the Lower Passaic River in contravention of the Congressionally authorized navigational depth and Section 10 of the Rivers and Harbors Act and that would accommodate reasonably anticipated future commercial navigational use, EPA evaluated USACE's 2010 Lower Passaic River Commercial Navigation Analysis report, which assessed the current and potential future status of commercial navigation on the Lower Passaic River.
- During the comment period, commenters stated that the analysis in the 2010 USACE report should be updated to include the latest data on navigation (waterborne commerce statistics) in the Lower Passaic River. By letter dated February 6, 2014, USACE confirmed that 2011 Waterborne Commerce Data (the last year analyzed as of the writing of the letter) indicated a significant volume of waterborne commerce was transported that year within the Lower Passaic River, consistent with its prior analysis of 1997-2006 data. The letter also stated that "The current and projected future level of commercial traffic is sufficient to justify maintenance dredging of the channel should it be required, subject to budget limitations."

- Based on EPA's reexamination of information pertaining to commercial navigation in recent years, EPA adjusted the depths of the navigation channel included in the selected remedy to better reflect current commercial use, as follows: 30 feet from RM 0 to RM 0.6 and 20 feet from RM 0.6 to RM 1.7. The selected remedy does not include any dredging above RM 1.7 except as needed to accommodate the engineered cap and to smooth some areas prior to cap placement to achieve a minimum final water depth of approximately 10 feet for reasonably anticipated future recreational uses.
- Since the selected remedy anticipates that from RM 0.6 to RM 8.3, the Lower Passaic River will be permanently capped at depths shallower than the federally authorized navigation channel depths, it will be necessary to obtain Congressional authorization to: 1) modify the authorized depth from RM 0.6 to RM 1.7; and 2) deauthorize the federal navigation channel from RM 1.7 to RM 8.3. USACE has advised that it will support those modification and deauthorization recommendations to Congress.
- The adjustment to the depths of the navigation channel, as well as a few other minor volume adjustments made in response to other comments, resulted in a change to the estimated dredging volume for the selected remedy of less than 20 percent, from 4.3 million cubic yards to 3.5 million cubic yards. Changes in construction time and cost are discussed below.

Opening and Closing of Bridges. EPA received comments expressing concern that implementation of the preferred alternative would require the bridges over the Passaic River to be opened and closed many times a day, disrupting road, rail and pedestrian traffic, adversely impacting businesses, interfering with emergency response and stressing aging infrastructure to the point of breakage. In response to these comments, EPA re-evaluated the bridges in the lower 8.3 miles:

- EPA concluded that out of 13 bridges, low profile barges exist that can pass beneath all but two of the bridges without opening them.
- The two bridges that present the greatest challenges to navigation as a result of vertical clearance handle vehicular traffic. They are located in the upper portion of the lower 8.3 miles, at RM 5.7 and RM 6.1. Accordingly, the amount of dredged material that will be moved past these bridges will be far less than the total of 3.5 million cubic yards addressed by the selected remedy. EPA concluded that there are a number of engineering options available to transport materials under these two bridges without opening them, and evaluated bypass pumping between RM 5.7 and RM 6.1 in detail in the Responsiveness Summary for inclusion in the cost estimate that supports the ROD. The final decision on the approach to be taken will be addressed during the remedial design phase.
- Although any of the bridges may still need to be opened to allow construction equipment through, such openings are expected to be infrequent events that can be timed to minimize transportation disruptions. This issue is not expected to pose an undue hardship to bridge operators or users. Necessary coordination, which may include assisting bridge authorities with engineering evaluations and maintenance of the bridges, will occur during the remedial design phase of the project.

Construction Time and Cost. EPA received comments stating that the construction time for the preferred alternative was underestimated. In response to these comments, EPA re-evaluated the following factors affecting dredging productivity raised by commenters:

- EPA added time to the schedule to more fully account for fish windows, allow for an additional three weeks of downtime for extreme weather events and equipment breakdown; and EPA revised construction sequencing to account for the engineering solutions discussed above that significantly reduced the need for bridge openings. EPA also made revisions to account for the adjustments in the depths of the navigation channel included in the selected remedy, as discussed above.
- These revisions did not substantially increase the total construction time for the active remedies. Changes were from 11 to 14 years for Alternative 2, from 5 to 6 years for Alternative 3 (the selected remedy) and from 2 to 2.5 years for Alternative 4. These increases did not change the relative durations among alternatives, and so did not change EPA's comparative analysis results from the Proposed Plan.
- These revisions also resulted in changes to the costs of the active remedies that did not change the relative costs among alternatives, and so did not change EPA's comparative analysis results from the Proposed Plan. Updated costs are presented in Section 9.2. For the selected remedy, present value costs changed approximately 20 percent, from $1.73 billion to $1.38 billion.

All of these estimates are based on limited data and will be refined during remedial design. All changes are within the expected accuracy of feasibility study cost estimates of +50 percent to -30 percent. They are within the range of adjustments that would normally be made during remedial design, and do not significantly change the selected remedy.